Original Investigation

Oral Anticoagulant Therapy Prescription in Patients With Atrial Fibrillation Across the Spectrum of Stroke Risk

Insights From the NCDR PINNACLE Registry

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IMPORTANCE Patients with atrial fibrillation (AF) are at a proportionally higher risk of stroke based on accumulation of well-defined risk factors.

OBJECTIVE To examine the extent to which prescription of an oral anticoagulant (OAC) in US cardiology practices increases as the number of stroke risk factors increases.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional registry study of outpatients with AF enrolled in the American College of Cardiology National Cardiovascular Data Registry's PINNACLE (Practice Innovation and Clinical Excellence) Registry between January 1, 2008, and December 30, 2012. As a measure of stroke risk, we calculated the $CHADS_2$ score and the CHA_2DS_2-VASc score for all patients. Using multinomial logistic regression models adjusted for patient, physician, and practice characteristics, we examined the association between increased stroke risk score and prescription of an OAC.

MAIN OUTCOMES AND MEASURES The primary outcome was prescription of an OAC with warfarin sodium or a non–vitamin K antagonist OAC.

RESULTS The study cohort comprised 429 417 outpatients with AF. Their mean (SD) age was 71.3 (12.9) years, and 55.8% were male. Prescribed treatment consisted of an OAC (192 600 [44.9%]), aspirin only (111 134 [25.9%]), aspirin plus a thienopyridine (23 454 [5.5%]), or no antithrombotic therapy (102 229 [23.8%]). Each 1-point increase in risk score was associated with increased odds of OAC prescription compared with aspirin-only prescription using the $CHADS_2$ score (adjusted odds ratio, 1.158; 95% CI, 1.144-1.172; $P < .001$) and the CHA_2DS_2-VASc score (adjusted odds ratio, 1.163; 95% CI, 1.157-1.169; $P < .001$). Overall, OAC prescription prevalence did not exceed 50% even in higher-risk patients with a $CHADS_2$ score exceeding 3 or a CHA_2DS_2-VASc score exceeding 4.

CONCLUSIONS AND RELEVANCE In a large quality improvement registry of outpatients with AF, prescription of OAC therapy increased with a higher $CHADS_2$ score and CHA_2DS_2-VASc score. However, a plateau of OAC prescription was observed, with less than half of high-risk patients receiving an OAC prescription.

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Atrial fibrillation (AF) is the most common cardiac arrhythmia, with an estimated 1 in 4 lifetime risk in those older than 40 years and a projected increase in prevalence to approximately 5.6 million affected individuals by 2050 in the United States.[1,2] Atrial fibrillation imparts stroke risk, and risk stratification schemes that include the $CHADS_2$ score[3] and, more recently, the CHA_2DS_2-VASc score[4] have been developed to estimate the risk of thromboembolism in patients with AF based on specific risk factors.[3,4] Consensus guidelines have called for the use of these risk stratification schemes to determine the absolute risk of stroke[5-7] and aid the health care professional in determining whether prescription of an oral anticoagulant (OAC) with warfarin sodium (a vitamin K antagonist) or the newer nonvitamin K antagonist OACs may be warranted for stroke risk reduction.[8-11] Although it is well known that appropriate OAC prescription in patients with AF at risk for stroke outside of clinical trial settings falls short of guideline-based expectations,[12-15] the extent to which prescription of OACs in real-world practice increases as the risk of stroke increases is less well known.

We evaluated the prevalence of OAC prescription by cardiovascular specialists in a cohort of outpatients using data from the American College of Cardiology's National Cardiovascular Data Registry (NCDR) Practice Innovation and Clinical Excellence (PINNACLE) Registry. The use of this prospective national registry of cardiovascular care in the United States provides a unique opportunity to examine patterns of OAC treatment in routine practice among outpatients. We sought to examine the prevalence of treatment with OACs, antiplatelet therapy only, or no antithrombotic therapy in patients with AF across the spectrum of stroke risk as established by the $CHADS_2$ score and the CHA_2DS_2-VASc score in real-world US cardiology practices.

Methods

Data Source

The NCDR PINNACLE Registry was created in 2008 by the American College of Cardiology as the first national, prospective, office-based cardiac quality improvement registry in the United States.[16,17] Participating academic and private practices collect longitudinal point-of-care data, including patient demographics, symptoms, comorbidities, vital signs, medications, laboratory values, and recent hospitalizations, with either paper forms or modification of a practice's electronic medical record using a standardized collection tool to comprehensively obtain and transmit uniform data. The NCDR data quality assurance is maintained through standardized data collection and transmission protocols, rigorous data definitions, and periodic data quality audits, which have shown much greater than 90% raw accuracy of data abstraction.[18,19] Quality checks and analyses of the data have been performed at Saint Luke's Mid America Heart Institute, the primary analytical center for the PINNACLE Registry. Waiver of written informed consent and authorization for this study was granted by Chesapeake Research Review Incorporated.

Study Population

There were 2 172 455 patients in the PINNACLE Registry between January 1, 2008, and December 30, 2012. We excluded 1 714 950 patients without a diagnosis of AF and 28 088 patients deemed not able to be prescribed antiplatelet or OAC therapy as assessed by the treating health care professional and specified on data collection forms. Therefore, our final study cohort comprised 429 417 patients with AF from 144 practices in 38 states across the United States. We characterized the study cohort using 2 different metrics to estimate thromboembolic risk in patients with AF. First, we used the traditional $CHADS_2$ score (with 1 point for congestive heart failure, hypertension, age ≥75 years, and diabetes mellitus and 2 points for stroke or transient ischemic attack[3]). Second, we used the CHA_2DS_2-VASc score (with 1 point for congestive heart failure, hypertension, age ≥65 years [2 points if age ≥75 years], diabetes mellitus, female sex, and coronary or peripheral arterial disease and 2 points for stroke or transient ischemic attack), a more sensitive tool to risk-stratify patients with AF who may be at risk for stroke and benefit from anticoagulant therapy.[4] The use of the CHA_2DS_2-VASc score may have influenced cardiovascular specialist prescription of an OAC during the study time frame as reflected in updated 2012 European Society of Cardiology guidelines[7] and subsequently published updated guidelines after the study.[6] These updated guidelines, published after the study time frame in 2014, advise the use of the CHA_2DS_2-VASc score for the assessment of stroke risk.[6] To minimize overrepresentation by patients with multiple visits, only data from the index visit of each patient during the study period were used. The index visit was considered the first encounter at which a diagnosis of AF was specified. To ensure that misclassification of OAC prescription was not overlooked by examining only the index visit, we performed a sensitivity analysis to determine the number of patients that would be reclassified as being prescribed an OAC by increasing the window from baseline to within 1 year after the index visit. Due to a high rate of data missingness (44.4%), analyses specific to patient race/ethnicity were not performed.

Study Outcomes

Our primary study outcome was treatment with any US Food and Drug Administration–approved OAC for stroke prevention in patients with AF, which included warfarin, dabigatran, or rivaroxaban (apixaban and edoxaban had not yet been approved by the Food and Drug Administration during the study time frame). Among patients not treated with anticoagulant therapy, we also examined whether these patients were treated with an antiplatelet agent (including aspirin alone or aspirin plus a thienopyridine) or were receiving neither OAC nor antiplatelet therapy. Treatment with a thienopyridine was defined as prescription of clopidogrel bisulfate, ticlopidine hydrochloride, or prasugrel.

Statistical Analysis

Normally distributed continuous variables are expressed as means (SDs), whereas categorical variables are expressed as proportions. Unadjusted differences were compared using χ^2 test for categorical variables and 1-way analysis of variance or *t* test for continuous variables, as appropriate.

Table 1. Baseline Characteristics of Patients With AF Across the Spectrum of Stroke Risk, Stratified by Prescription of an Oral Anticoagulant

Characteristic	Total Cohort (N = 429 417)	Prescribed Oral Anticoagulant		*P* Value	Standardized Difference
		Yes (n = 192 600)	No (n = 236 817)		
Patient Demographic Characteristics					
Age, mean (SD), y	71.3 (12.9)	73.2 (11.0)	69.7 (14.0)	<.001	6.67
Male sex, %	55.8	57.5	54.5	<.001	6.02
$CHADS_2$ score, mean (SD)	2.0 (1.3)	2.1 (1.2)	1.9 (1.3)	<.001	20.04
CHA_2DS_2-VASc score, mean (SD)	3.7 (1.8)	3.8 (1.7)	3.5 (1.8)	<.001	18.51
Comorbidities, %					
Hypertension	76.8	80.4	74.0	<.001	6.67
Coronary artery disease	49.7	48.6	50.5	<.001	3.79
Unstable angina	1.0	0.8	1.2	<.001	4.43
Stable angina	6.4	4.8	7.7	<.001	12.01
Dyslipidemia	55.2	57.5	53.4	<.001	8.39
Congestive heart failure	24.9	28.4	22.1	<.001	14.50
Prior stroke or transient ischemic attack	14.3	14.8	13.8	<.001	2.81
Prior systemic embolism	1.2	1.4	1.0	<.001	3.91
Peripheral arterial disease	8.5	7.7	9.0	<.001	4.65
Diabetes mellitus	22.9	23.7	22.2	<.001	3.67
Prior myocardial infarction	17.9	18.1	17.7	<.001	1.04
Prior CABG surgery	8.7	8.5	9.0	<.001	1.69
Institutional Characteristics					
US region, %					
Northeast	13.5	14.6	12.6	<.001	8.47
Midwest	28.2	34.1	23.3		24.05
South	38.7	33.5	43.0		19.57
West	19.6	17.8	21.1		5.87
Urban location, %	86.7	89.1	84.7	<.001	12.98
Clinic volume, mean (SD) visits per year	36 276.5 (27 661.9)	36 915.4 (27 261.5)	35 756.9 (27 972.6)	<.001	4.19
Health care professional designation, %					
Physician	94.2	94.3	94.2	<.001	1.11
Nurse practitioner	4.1	4.4	3.9		2.82
Other	1.6	1.2	1.9		1.20

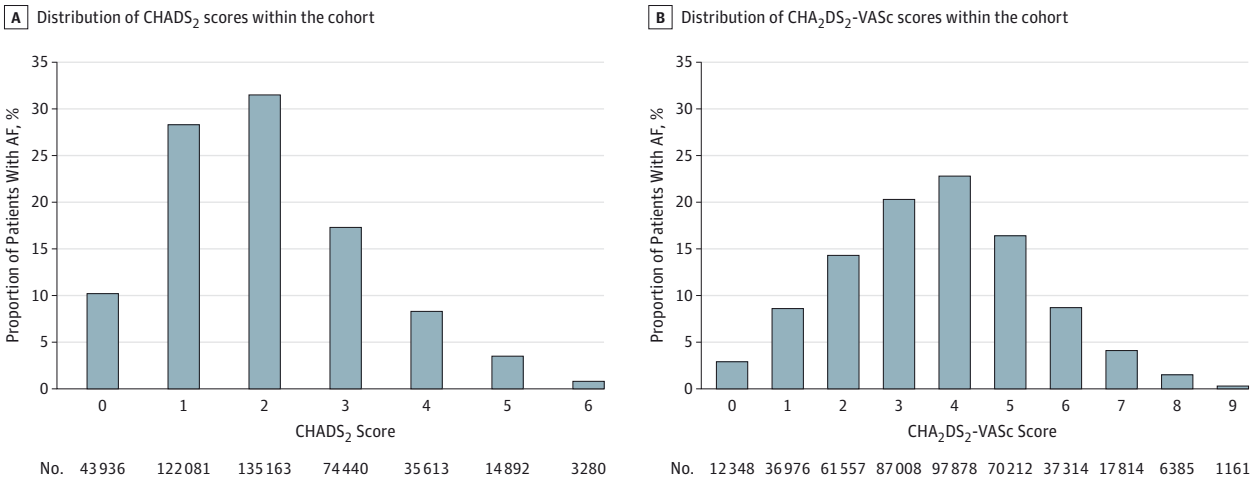
Abbreviations: AF, atrial fibrillation; CABG, coronary artery bypass graft.

To investigate the independent associations of the $CHADS_2$ score and the CHA_2DS_2-VASc score as continuous variables with the outcome of antithrombotic therapy prescription, we constructed multinomial logistic regression models adjusted for patient demographic, clinical, and practice characteristics. These models included site as a random effect to account for patient clustering within sites. Covariates considered to be potential confounders were entered in the multivariable model and included sex, unstable angina, dyslipidemia, prior coronary artery bypass graft surgery, prior percutaneous coronary intervention, US region, urban location, clinic volume, and health care professional designation. Patient characteristics that comprised the $CHADS_2$ score or the CHA_2DS_2-VASc score were not included in the multivariable model to avoid collinearity. Covariates selected for the multivariable analyses were chosen based on the plausibility that they could be associated with differential prescription of anticoagulation. Statistical tests were 2 sided and considered significant if they yielded $P < .05$. Analyses were performed using statistical software packages, including SAS (version 9.3; SAS Institute Inc), R (version 2.15.3; R Foundation for Statistical Computing), and IVEWare (Institute for Social Research, University of Michigan, Ann Arbor).

Results

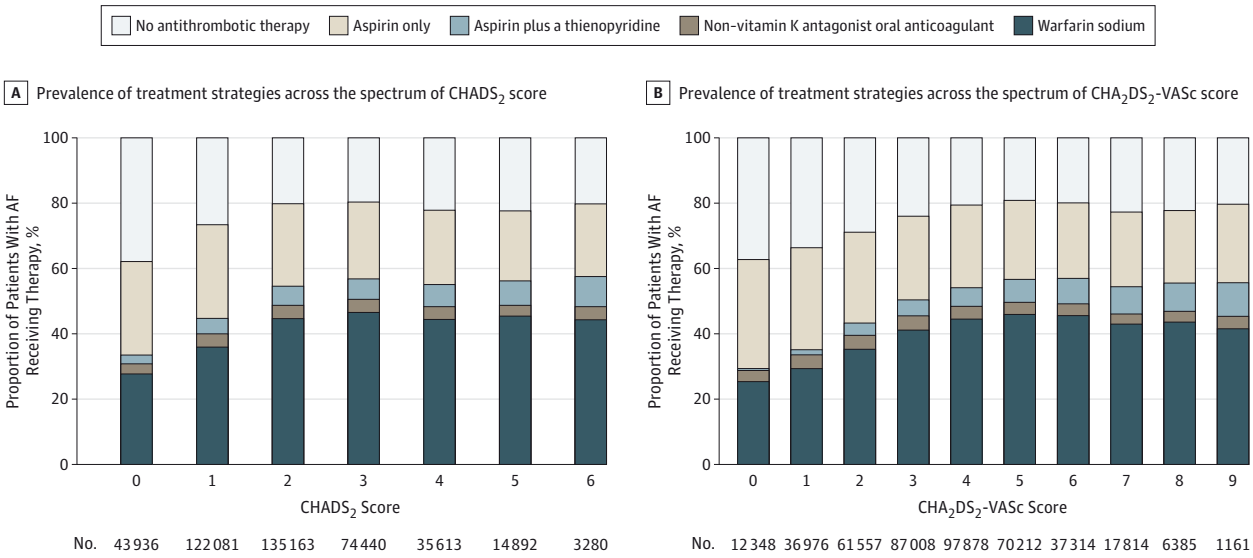
Demographic, clinical, and institutional characteristics among the 429 417 patients with AF in the overall cohort, stratified by prescription of an OAC, are summarized in **Table 1**. Some absolute differences in baseline characteristics were small but statistically significant between those prescribed an OAC and those not prescribed an OAC. Patients with AF prescribed an OAC were older, more often male, and more often resided in the Northeast and Midwest. Patients prescribed an OAC were more likely to have a history of hypertension, dyslipidemia, congestive heart failure, diabetes mellitus, prior stroke or transient ischemic attack, prior systemic embolism, and prior

Figure 1. Prevalence of Patients With Atrial Fibrillation (AF) Across the Spectrum of the $CHADS_2$ Score and the CHA_2DS_2-VASc Score



Shown is the distribution of patients with AF in the cohort characterized by the $CHADS_2$ score (A) and the CHA_2DS_2-VASc score (B).

Figure 2. Prevalence of Antithrombotic Therapies in Patients With Atrial Fibrillation (AF) Across the Spectrum of Stroke Risk by the $CHADS_2$ Score and the CHA_2DS_2-VASc Score



Shown is the proportion of patients treated with different antithrombotic therapies based on the $CHADS_2$ score (A) and the CHA_2DS_2-VASc score (B). Oral anticoagulant therapy was defined as prescription of either warfarin sodium, dabigatran, or rivaroxaban, further stratified by warfarin (dark blue) vs dabigatran or rivaroxaban (dark brown). Other treatment strategies included prescription of aspirin only (light brown), aspirin plus a thienopyridine (light blue), or no antithrombotic therapy (light grey). Treatment with a thienopyridine was defined as prescription of clopidogrel bisulfate, ticlopidine hydrochloride, or prasugrel.

myocardial infarction. Patients prescribed an OAC were less likely to have coronary artery disease, unstable angina, stable angina, peripheral arterial disease, and prior coronary artery bypass graft surgery.

The cohort's mean (SD) $CHADS_2$ score and CHA_2DS_2-VASc score were 2.0 (1.3) and 3.7 (1.8), respectively (Table 1). The full distribution of patient $CHADS_2$ scores and CHA_2DS_2-VASc scores is shown in **Figure 1**.

A total of 192 600 patients (44.9%) with AF were prescribed an OAC. Warfarin was the most commonly used therapy (173 832 [90.3%]), followed by dabigatran (14 896 [7.7%]) and rivaroxaban (3872 [2.0%]). Of the total cohort, 111 134 patients (25.9%) were prescribed aspirin only, 23 454 patients (5.5%) were prescribed aspirin plus thienopyridine dual antiplatelet therapy, and 102 229 patients (23.8%) were prescribed no antithrombotic therapy. The prevalence of prescription of an OAC (stratified by warfarin vs dabigatran or rivaroxaban), aspirin only, aspirin plus a thienopyridine, and no antithrombotic therapy across the spectrum of the $CHADS_2$ score and the CHA_2DS_2-VASc score is shown in **Figure 2**. Patients with AF with

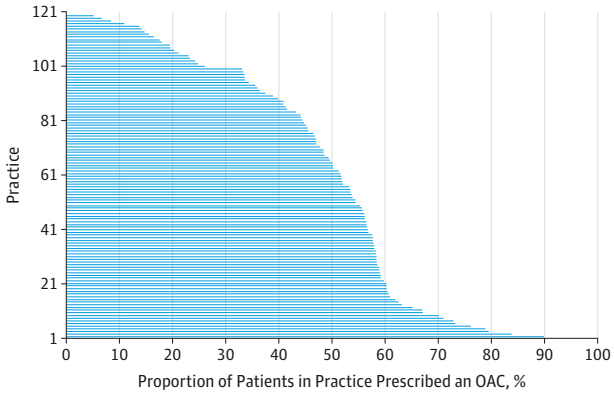
a $CHADS_2$ score of 3 and a CHA_2DS_2-VASc score of 5 were most often prescribed anticoagulation at 50.6% and 49.7%, respectively. Oral anticoagulant prescription did not exceed 50% even in higher-risk patients, including patients with AF with a $CHADS_2$ score exceeding 3 or a CHA_2DS_2-VASc score exceeding 4. The prevalence of non-vitamin K antagonist OAC (dabigatran and rivaroxaban) prescription did not exceed 4.5% across the $CHADS_2$ score and the CHA_2DS_2-VASc score. In a sensitivity analysis evaluating reclassification of patients prescribed an OAC within 1 year of the index visit, a small proportion of patients (4859 [2.1%]) not prescribed an anticoagulant at baseline were prescribed an OAC in follow-up. Evaluation of practice-level variation of OAC prescription revealed that the median practice rate for OAC prescription was 51.7%. There was significant variation in OAC prescription, with an interquartile range of 37.7% to 58.3% (**Figure 3**).

In both unadjusted and multivariable-adjusted analyses, each 1-point increase in the $CHADS_2$ score and the CHA_2DS_2-VASc score was significantly associated with greater odds of both antiplatelet therapy and OAC prescription (**Table 2**). Notably, for each 1-point increase in the $CHADS_2$ score, patients with AF had a 16.6% greater odds of OAC prescription vs no antithrombotic therapy prescription (adjusted odds ratio [OR], 1.166; 95% CI, 1.152-1.180; $P < .001$) and a 15.8% greater odds of OAC prescription vs aspirin-only prescription (adjusted OR, 1.158; 95% CI, 1.144-1.172; $P < .001$). Similarly, for each 1-point increase in the CHA_2DS_2-VASc score, the same patients had a 19.0% greater odds of OAC prescription vs no antithrombotic therapy (adjusted OR, 1.190; 95% CI, 1.184-1.196; $P < .001$) and a 16.3% greater odds of OAC prescription vs aspirin-only prescription (adjusted OR, 1.163; 95% CI, 1.157-1.169; $P < .001$). The association of all covariates included in the adjusted multivariable models evaluating the $CHADS_2$ score and the CHA_2DS_2-VASc score and the odds of antithrombotic therapy prescription are summarized in the eTable in the Supplement.

Discussion

In a large quality improvement registry of 429 417 outpatients with AF across the spectrum of stroke risk as measured by the $CHADS_2$ score and the CHA_2DS_2-VASc score, each 1-point increase in either score was associated with an approximately 15% greater adjusted odds of OAC prescription. Overall, there appeared to be a plateau effect of OAC prescription across the spectrum of stroke risk because patients with a $CHADS_2$ score exceeding 3 or a CHA_2DS_2-VASc score exceeding 4 were often not prescribed an OAC even when compared with their lower-risk counterparts, and OAC prescription did not exceed 50% in these highest-risk patients. Our findings have important implications for patients with AF, particularly because annual stroke risk increases with the number of stroke risk factors measured by the $CHADS_2$ score and the CHA_2DS_2-VASc score.[3,4] Therefore, the lack of guideline-adhering prescription of OACs for stroke prophylaxis in patients with the highest $CHADS_2$ scores and CHA_2DS_2-VASc scores should draw attention to a treatment gap in patients who may most appropriately need OAC therapy.

Figure 3. Variation in Oral Anticoagulant (OAC) Prescription Prevalence Across Practices



The median practice treatment prevalence with OAC therapy was 51.7%, with an interquartile range of 37.7% to 58.3%. Each practice is given a number representing the proportion of patients with atrial fibrillation within that practice prescribed an OAC.

Despite a well-established association of AF with stroke, significant lack of OAC prescription to reduce thromboembolism in at-risk candidates has been demonstrated in several large-scale studies.[13,20,21] These previous studies described primarily US patients in the era of warfarin therapy and before the promulgation of the importance of stroke risk scores to aid in risk stratification. Clinical risk scores that include the $CHADS_2$ score and the CHA_2DS_2-VASc score have been developed to elucidate and quantify stroke risk in patients with AF to aid in the decision to prescribe antithrombotic therapies.[3,4] In our study, we used the $CHADS_2$ score because this risk scheme was the predominant scoring system contemporary with the study period.[22] To expand on the robustness of our findings, we also studied the same cohort of patients with AF as assessed by the CHA_2DS_2-VASc score because this risk scheme may improve discrimination of patients with AF at risk for stroke and thromboembolism and is supported by updated guidelines published near the end of and after the time frame of the study.[6,7,23] In the GARFIELD (Global Anticoagulant Registry in the FIELD) multinational observational study[24] of 10 614 patients with AF enrolled between 2009 and 2011 at 540 sites in 19 non-US countries and cared for by general practitioners, cardiologists, and neurologists, 38.0% of patients with a $CHADS_2$ score of 2 or higher did not receive anticoagulant therapy. A similar plateau effect as seen in our study was observed at higher ranges of $CHADS_2$ scores and CHA_2DS_2-VASc scores in the GARFIELD registry. Our cohort was completely composed of patients from the United States treated by cardiovascular specialists. The lack of prescription of an OAC by cardiovascular specialists in more than 50% of patients at the highest thromboembolic risk categories suggests that US cardiovascular health care professionals, who should be well versed in guideline-based therapy for AF, may not fully appreciate the continued increased risk of thromboembolism with accumulation of additional stroke risk factors. This deficit has been highlighted in the lack of correlation between empirical risk scores and physician assessment of stroke risk in 10 094 patients with AF in the ORBIT-AF

Table 2. Association of the $CHADS_2$ Score and the CHA_2DS_2-VASc Score With Prescription of Antithrombotic Therapy

	$CHADS_2$ Score				CHA_2DS_2-VASc Score			
	Unadjusted Analysis		Adjusted Analysis[a]		Unadjusted Analysis		Adjusted Analysis[b]	
Antithrombotic Therapy Prescription	OR (95% CI)[c]	*P* Value	Adjusted OR (95% CI)[c]	*P* Value	OR (95% CI)[c]	*P* Value	Adjusted OR (95% CI)[c]	*P* Value
No antithrombotic therapy	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Oral anticoagulant	1.248 (1.240-1.256)	<.001	1.166 (1.152-1.180)	<.001	1.174 (1.168-1.179)	<.001	1.190 (1.184-1.196)	<.001
Aspirin plus a thienopyridine	1.350 (1.335-1.365)	<.001	1.189 (1.181-1.196)	<.001	1.354 (1.343-1.365)	<.001	1.274 (1.262-1.286)	<.001
Aspirin only	1.065 (1.057-1.072)	<.001	1.011 (1.003-1.018)	.01	1.049 (1.044-1.055)	<.001	1.031 (1.025-1.036)	<.001
Aspirin only	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Oral anticoagulant	1.172 (1.165-1.179)	<.001	1.158 (1.144-1.172)	<.001	1.119 (1.114-1.23)	<.001	1.163 (1.157-1.169)	<.001
Aspirin plus a thienopyridine	1.267 (1.254-1.281)	<.001	1.185 (1.178-1.193)	<.001	1.290 (1.280-1.301)	<.001	1.254 (1.242-1.267)	<.001

Abbreviations: CABG, coronary artery bypass graft; NA, not applicable; OR, odds ratio.

[a] Adjusted for sex, unstable angina, dyslipidemia, prior CABG surgery, prior percutaneous coronary intervention, US region, urban location, clinic volume, and health care professional designation.

[b] Adjusted for unstable angina, dyslipidemia, prior CABG surgery, prior percutaneous coronary intervention, US region, urban location, clinic volume, and health care professional designation.

[c] The OR represents the odds of antithrombotic therapy prescription compared with the reference group (either no antithrombotic therapy or aspirin only) per 1-point score increase in the continuous predictor variable ($CHADS_2$ score and CHA_2DS_2-VASc score).

(Outcomes Registry for Better Informed Treatment of Atrial Fibrillation).[25] Other explanations need to be entertained for the lack of OAC prescription in high-risk patients, including justifiable clinical reasons or patient refusal of this therapy. Differences in OAC prescription prevalence between the ORBIT-AF and the PINNACLE Registry may not be directly comparable. In general, the PINNACLE Registry cohort was composed of a much larger population of patients with AF treated specifically by cardiovascular disease specialists, whereas the industry-sponsored ORBIT-AF was a smaller cohort and also included patients with AF treated by internists. We observed a lower prevalence of OAC prescription in the South compared with the Midwest and Northeast. The reason for such variation in treatment patterns among different regions in the United States is unclear but may be related to differences in insurance coverage, socioeconomic status, or exposure of health care professionals in different regions to guidelines through educational programs.

The reasons underlying the associations observed, particularly the plateau effect at higher risk scores, remain unknown. Because many of the risk factors incorporated into the $CHADS_2$ score and the CHA_2DS_2-VASc score that predict stroke risk in patients with AF are the same risk factors that predict bleeding complications in patients prescribed an OAC (eg, the HAS-BLED score[26]), health care professionals may be more reluctant to prescribe anticoagulation in these sicker patients due to concerns regarding bleeding risk. Most important, despite the heightened bleeding risk with higher HAS-BLED scores, the benefit of anticoagulation continues to outweigh the risk as all of these scores increase.[27] In addition, risk factors for stroke, such as age, diabetes mellitus, hypertension, prior stroke or transient ischemic attack, or coronary artery disease and its equivalents (eg, angina and previous revascularization), may necessitate treatment with aspirin or even aspirin plus thienopyridine dual antiplatelet therapy. Given increased risk of bleeding with the addition of an OAC to antiplatelet therapy[28] or the incorrect perception that antiplatelet therapy (even when aspirin is combined with clopidogrel) has a similar efficacy as anticoagulation,[29,30] health care professionals may avoid additional antithrombotic therapy in patients taking antiplatelet therapy. However, because more than 50% of high-risk patients had anticoagulation withheld in the absence of antiplatelet therapy, these considerations cannot fully explain our results. Although we focused on relationships between established stroke risk scores and anticoagulation prescription across the entire PINNACLE Registry, there was significant variability among individual practices (Figure 3). This finding suggests that focusing on factors pertinent to practices that are the least and most compliant with related guideline adherence may prove fruitful in efforts to rectify inadequate anticoagulation prescription more broadly.

Because dabigatran and rivaroxaban were approved toward the end of our study time frame, most patients prescribed an OAC in our cohort were prescribed warfarin. Our study time frame concluded in 2012, and it is possible that practice patterns may have changed since that time given the subsequent growing availability of several approved OACs. Although 4 non–vitamin K antagonist OACs are now available in clinical practice, warfarin remains the most common drug prescription for anticoagulation in AF,[31] making these data relevant to contemporary practice.

Our study has some limitations. First, while the PINNACLE Registry ascertains whether an anticoagulant is contraindicated, the data are not sufficiently granular to calculate the HAS-BLED score (ie, the PINNACLE Registry does not capture data on medication use predisposing to bleeding, labile international normalized ratios, or alcohol or drug use).[26] This additional information may have been helpful to quantify the bleeding risk among those who did and did not receive an anticoagulation prescription. Second, the

PINNACLE program enrolled patients from 144 academic and private cardiology practices in 38 states across the United States, which are potentially more dedicated to quality improvement. Therefore, antithrombotic therapy prescription patterns in other US or international practices or by noncardiology health care professionals may differ from those reported in this study, potentially reducing the generalizability of our results. Third, specific data are unavailable regarding previous bleeding complications or exact reasons for contraindications to anticoagulant therapy; therefore, we cannot determine the validity of a reported contraindication. Although the lack of this and other outcome data, such as stroke and major bleeding events, are shortcomings of the PINNACLE Registry, the large number of patients included in our analyses provides substantial power in evaluating the primary focus of our analyses, which is prescription of an OAC in patients with AF across the spectrum of stroke risk. Fourth, the main data analyzed consisted of OAC prescription at the index AF visit. Although the index visit may not capture OAC prescription at any time in patient follow-up, a sensitivity analysis that included follow-up visits until 1 year after the index visit demonstrated that only a small proportion of additional patients (approximately 2%) were prescribed an OAC. Fifth, some may argue that the PINNACLE data collection form may not reflect actual prescription of the drug and much less what patients actually receive or consume. However, that distinction is arguably minimally relevant for the purposes of this study because it is likely that the data recorded on the form more purely mirror the intent or perceived "correct" prescription of medications. Nevertheless, we cannot rule out the possibility that, despite best efforts for accurate data collection, underreporting of OAC prescription occurred by those recording this information.

Conclusions

Data from this quality improvement registry of cardiology outpatients with AF across the spectrum of stroke risk suggest that cardiovascular disease specialists were more likely to prescribe an OAC as the number of stroke risk factors increased based on both the $CHADS_2$ score and the CHA_2DS_2-VASc score. However, less than 50% of all patients at the highest ranges of stroke risk were prescribed an OAC. These findings draw attention to important gaps in appropriate treatment of patients with AF at the highest risk of stroke and highlight opportunities to understand the reasons behind these gaps and insights to improve them.

ARTICLE INFORMATION

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