ATRIAL FIBRILLATION

RESEARCH ARTICLE

Electronic Medical Record (EMR)-derived Appropriate Inpatient Risk Stratification and Anticoagulant Treatment of Atrial Fibrillation at a Large Academic Medical Center: Opportunities for EMR-based Clinical Decision-making Support Tools

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ABSTRACT. Risk assessment of potential stroke in patients with atrial fibrillation (AF) is a fundamental component of AF disease management. Electronic medical record (EMR) use affords clinicians easier access to key cardiovascular risk factors when treating AF patients. The primary focus of this study was to evaluate documented risk assessment via widely accepted risk stratification schemes and subsequent appropriate anticoagulant therapy in AF patients at an academic medical center. We performed a retrospective chart review of hospitalized adult patients possessing a discharge diagnosis of AF. In the event of multiple admissions, the patient's initial hospitalization within the specified time period was evaluated. Patients identified were separated into those initiated on oral anticoagulation (OAC) during hospitalization and those who were not. Patients not started on OAC therapy were analyzed to determine the appropriateness of withholding OAC agents. Of 262 OAC-eligible patients not receiving anticoagulation, CHADS₂ was documented in the EMR for 60 patients (23%), and CHA₂DS₂-VASc was documented for nine patients (3%). Three patients (1%) not receiving anticoagulation had both CHADS₂ and CHA₂DS₂-VASc documented. Based on calculated risk stratification and the documented presence of contraindications, 32 of 262 patients (12%) were considered to have OAC therapy inappropriately omitted. Hypertension emerged as the single predictor of inappropriate omission of OAC therapy in these patients. Despite EMR implementation, a significant number of OAC-eligible AF patients do not receive appropriate anticoagulant therapy. EMR-based clinical decision support tools boosting awareness of patient OAC eligibility may improve compliance with guideline-based AF treatment strategies.

KEYWORDS. Anticoagulation, atrial fibrillation, electronic medical record, information technology.

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Introduction

Atrial fibrillation (AF) is a commonly encountered cardiac arrhythmia in clinical practice. Risk factors for the development of AF include comorbid cardiovascular

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diseases (e.g. coronary artery disease, hypertension, etc.), cardiac structural remodeling, and electrophysiologic changes occurring at the myocardial level.¹ Patients with AF are at an increased risk for morbidity and mortality from thromboembolism and stroke.¹ However, the annualized risk of stroke in patients with AF varies and is affected by the presence or absence of certain patient-specific characteristics.^{1,2} Several cardiovascular risk stratification schemes have been developed in an effort to effectively identify high-risk patients who would benefit most from antithrombotic therapy to reduce the risk of ischemic stroke.

The *Antithrombotic Therapy and Prevention of Thrombosis*, 9th ed., published by the American College of Chest Physicians in 2012 recommends the use of the CHADS₂ score to assess stroke risk in patients with non-valvular AF, thereby guiding appropriate medical therapy.² The CHADS₂ scoring system assigns 1 point for a diagnosis of heart failure, a diagnosis of hypertension, age greater than or equal to 75 years, and a diagnosis of diabetes, and 2 points for a history of stroke or thromboembolic event.³ This guideline endorses no antithrombotic therapy for a CHADS₂ score of 0 (low risk), treatment with an oral anticoagulant for a CHADS₂ score of 1 (intermediate risk), and treatment with an oral anticoagulant for a CHADS₂ score of 2 or greater (high risk).²

More recently, the *AHA/ACC/HRS Guideline for the Management of Patients with Atrial Fibrillation* has recommended the use of the CHA₂DS₂-VASc scoring system for stroke risk stratification.¹ The CHA₂DS₂-VASc scoring system assigns 1 point for each of the following patient characteristics/diagnoses: congestive heart failure, hypertension, age between 65 and 74 years, diabetes, peripheral vascular disease, and female gender. The CHA₂DS₂-VASc system assigns 2 points for the following characteristics: patient age ≥ 75 years and history of prior stroke or arterial thromboembolic event.⁴ For patients with non-valvular AF, no antithrombotic therapy may be considered for a CHA₂DS₂-VASc score of 0 (low risk), no antithrombotic therapy or treatment with aspirin or an oral anticoagulant may be considered for a CHA₂DS₂-VASc score of 1 (intermediate risk), and treatment with an oral anticoagulant is recommended for a CHA₂DS₂-VASc score of 2 or greater (high risk). This guideline emphasizes the individualization of antithrombotic therapy based on stroke risk, bleeding risk, and patient-specific values and preferences.¹

Despite literature supporting the utilization of simplified risk stratification schemes such as the CHADS₂ or CHA₂DS₂-VASc in AF patients, there is not currently a standardized electronic medical record (EMR)-based protocol or algorithm for AF risk stratification at many medical centers. Therefore, the aims of this study were to determine whether patients with documented AF were routinely evaluated for stroke risk via documented risk assessment tools such as CHADS₂ or CHA₂DS₂-VASc and to determine if appropriate documentation existed within the EMR that justified withholding oral anticoagulation (OAC) therapy in otherwise OAC-eligible AF patients.

Materials and methods

A retrospective chart review was performed and included adult patients ≥ 18 years old who were admitted between March 2012 and September 2014 and who also possessed a discharge diagnosis of AF. Patients were identified via the University Health Consortium clinical database. In the event of multiple admissions, the patient's first hospitalization within the given time period was evaluated. Identified patients were then separated into two groups: those who were initiated on OAC therapy during the index hospitalization, and those who were not. Patients not started on OAC therapy were further analyzed and subdivided into two groups: those who had appropriate withholding of OAC, and those who did not. Appropriate withholding of OAC therapy was determined by the patient's calculated CHA₂DS₂-VASc score, documentation of a contraindication to anticoagulant therapy (e.g. active bleeding, blood dyscrasias, hypersensitivity, supratherapeutic international normalized ratio, etc.), anticipated surgical procedure, or documented patient refusal of OAC therapy. This study was approved by the institutional review board.

The primary outcome of this study was the presence or absence of appropriately documented AF risk stratification in patients who were not started on OAC therapy. The secondary outcome of this study was the determination of patient-specific risk factors associated with the inappropriate omission of OAC.

Statistical analysis

In the subset of patients that did not receive OAC therapy, descriptive statistics were used to report subject characteristics. All means are presented with standard deviations, and all medians are presented with interquartile ranges. Chi-square tests and univariate logistic regression were used to determine and quantify the association between categorical demographic and clinical variables with the outcome of appropriate withholding of anticoagulation treatment (yes or no). The clinical variables that make up the CHADS₂ and CHA₂DS₂-VASc scores were used in multiple logistic regression models to assess the association of each to the outcome while controlling for the others. Stepwise logistic regression was used to determine the most parsimonious models. SAS 9.3 (SAS Institute, Inc., Care, NC) was used for all analyses and statistical significance was determined at $p < 0.05$.

Results

Patient demographics

A total of 2,032 patients were identified as having a discharge diagnosis of AF during the specified time period. Of these, 262 (12.8%) patients did not receive anticoagulation during their index hospitalization. For these 262 patients, the mean calculated CHADS₂ score was 2 ± 1.3 points, and the mean calculated CHA₂DS₂-VASc score was 3.4 ± 1.7 points. **Table 1** summarizes baseline patient demographic data. Appropriate-use

analysis of these 262 patients in whom OAC therapy was not administered revealed that 230 (88%) were considered to have anticoagulation appropriately withheld, while 32 patients (12%) were considered to have OAC inappropriately omitted.

Primary outcome

A CHADS₂ score was documented in the EMR for 60 out of 262 patients (23%) who did not receive anticoagulation. A CHA₂DS₂-VASc score was documented in the EMR for nine out of 262 (3%) patients who did not receive anticoagulation. Only three patients (1%) who did not receive OAC therapy had both CHADS₂ and CHA₂DS₂-VASc documented in the EMR. (Table 2)

Twelve of the 32 (38%) patients who had OAC therapy inappropriately omitted had a documented CHADS₂ score compared with 48 out of 230 (21%) patients who had anticoagulation appropriately withheld ($p = 0.040$). However, there was no statistically significant difference associated with the documentation of a CHA₂DS₂-VASc score between these two groups ($p = 0.60$).

Secondary outcome

Patient characteristics were analyzed for association with the inappropriate omission of OAC. Thirty of 32 patients

(94%) who had OAC inappropriately omitted possessed a diagnosis of hypertension compared with 178 out of 230 patients (77%) who had anticoagulation appropriately withheld ($p = 0.03$). Conversely, there was no statistically significant difference between the two groups with regard to age, race, gender, heart failure diagnosis, diabetes diagnosis, history of stroke or thromboembolic event, and vascular disease diagnosis.

In a stepwise logistic regression model that included the five variables comprising the CHADS₂ score, both hypertension and diabetes remained in the model. The adjusted odds ratio for hypertension was 0.2 (95% CI 0.045–0.86; $p = 0.03$), indicating that the diagnosis of hypertension represented a significant predictor of inappropriate omission of OAC treatment. In contrast, the adjusted odds ratio for diabetes was 2.63 (95% CI 1.03–6.71; $p = 0.043$), suggesting diabetes to be a significant predictor for the appropriate withholding of anticoagulation treatment. In a stepwise multivariate logistic regression analysis including the eight variables comprising the CHA₂DS₂-VASc score, the two variables that remained in the model were hypertension and diabetes. Again, hypertension was determined to be a significant predictor of inappropriate omission of anticoagulation treatment ($p = 0.031$), while diabetes was determined to be significant predictor for the appropriate withholding of anticoagulation treatment ($p = 0.036$).

Discussion

In our study population of AF patients, we identified a subset of patients who failed to receive guideline-directed OAC therapy for the prevention of stroke despite a lack of documented OAC contraindications contained within the EMR. Factors influencing the inappropriate omission of OAC from these patients may be multifactorial in origin and could include unawareness of AF stroke risk assessment tools such as the CHADS₂ scoring systems, inaccurate documentation or physician bias.

In this study population, AF risk stratification via CHA₂DS₂-VASc was documented in the EMR for only nine out of 262 patients who did not receive anticoagulation (3%). These findings support our assertion that a lack of provider awareness of simple AF risk stratification tools may have influenced the inappropriate

Table 1: Demographic data of patients in whom oral anticoagulation therapy was withheld ($n = 262$)

Characteristic	n (%)
Age 65–74 years	75 (29)
Age ≥ 75 years	106 (40)
Female sex	103 (39)
Caucasian	174 (66)
Heart failure	64 (24)
Hypertension	208 (79)
Diabetes	85 (32)
Stroke, transient ischemic attack, or thromboembolism	33 (13)
Vascular disease	63 (24)
Calculated CHADS ₂ , mean $\pm$ SD	2 $\pm$ 1.3
Calculated CHA ₂ DS ₂ -VASc, mean $\pm$ SD	3.4 $\pm$ 1.7

Table 2: Comparison of groups based upon CHA₂DS₂-VASc scoring criteria ($n = 262$)

	Anticoagulation inappropriately omitted ($n = 32$)	Anticoagulation appropriately withheld ($n = 230$)	p
Diagnosis of heart failure	34%	23%	0.16
Diagnosis of hypertension	94%	77%	0.032
Age ≥ 75 years	31%	42%	0.26
Diagnosis of diabetes	19%	34%	0.077
History of stroke, transient ischemic attack, or thromboembolism	6%	13%	0.39
Diagnosis of vascular disease	16%	25%	0.23
Age 65–74 years	31%	28%	0.73
Female gender	47%	38%	0.35

omission of OAC therapy in these patients. One potential strength of EMR-based physician documentation would be the availability of clinical alerts once a formal diagnosis of AF is entered into the EMR. These types of alerts are widely used within our health system for conditions such as medication interactions and sepsis alerts. Our findings support the potential role for integrating a simple AF alert into EMR systems to remind clinicians to perform AF risk stratification via the two CHADS scoring systems.

Our analysis of patients who had inappropriately omitted OAC therapy sought to investigate the role that certain patient-specific characteristics may play in predicting which patients were affected. In this cohort of patients, only hypertension was considered to be predictive of the inappropriate omission of anticoagulation. The diagnosis of diabetes was associated with the appropriate withholding of OAC therapy in this cohort. It is not clear how the presence or absence of these diagnoses may have influenced provider treatment strategies of this AF cohort. Nevertheless, these findings are important owing to the prevalence of these two disease processes in our regional patient populations affected with AF.^{5,6}

Chae et al.⁷ reported on a lack of appropriate utilization of warfarin in AF patients with low to intermediate risk of stroke in a retrospective analysis of a large academic medical system database. However, their analysis did not include data surrounding the degree of appropriate documentation of either CHADS₂ scoring system within the EMR systems they queried. Navar-Bogan et al.⁸ also demonstrated a similar finding upon review of another large academic medical system's EMR. In their retrospective analysis of 6,397 patients, 58.3% of AF patients with a CHADS₂ score of ≥ 2 and 56% of patients with a CHA₂DS₂-VAsC score of ≥ 2 were prescribed appropriate OAC therapy. However, in this study, the patient-specific CHADS₂ scoring systems' values were calculated post hoc, and the rate of appropriate clinical EMR-based risk scoring was not included in their analysis. Lang et al.⁹ recently described significant variation in appropriate OAC therapy for AF patients who were identified within large federal and commercial payer databases. In over 115,000 patients who met criteria for OAC therapy, between 42% and 82% of patients did not receive an OAC agent.⁹

Cook et al.¹⁰ recently published the results of a small cohort study that examined the utility of an automated clinical alert system for patients with newly diagnosed AF. Despite the implementation of this alert system, the rates of OAC use in appropriate AF candidates did not differ significantly from controls (OR = 0.66; 95% CI, 0.37–1.17). A large multicenter prospective trial examining the effectiveness of an EMR-based clinical decision tool is currently enrolling (AURAS-AF), and the results of this study are hoped to further illuminate the role of automated techniques in AF risk stratification and therapy.¹¹

Limitations

This study has several limitations. First, all data were collected via retrospective chart review and, therefore,

are heavily dependent upon the accuracy of physician and nursing documentation. Moreover, this was a small study population at a single academic medical center receiving care over a relatively short time period. The time period chosen may not have represented the true use of the CHA₂DS₂-VAsC score calculation because of the publication of national guidelines in December 2014. Although these limitations are certainly valid, in the new era of EMR-based documentation, numerous quality and value decisions are made at both the local and national levels based upon the clinical data contained within EMR systems. Hence, this study, while limited in nature, highlights potential opportunities for clinical improvement via incorporating simple EMR driven risk assessment tools for AF patients.

Conclusions and implications

In a large cohort of AF patients treated at an EMR-based academic medical center, a significant subset of patients failed to receive guideline directed appropriate OAC therapy for the prevention of stroke in the absence of both documented AF risk stratification scoring in combination with a lack of documented OAC contraindications. Multivariate modeling identified only the diagnosis of hypertension as being predictive of inappropriate omission of OAC therapy in eligible patients. These findings support enhanced clinician education efforts with respect to guidelines-driven AF treatment strategies and define potential opportunities for integration of AF-specific automated clinical decision support tools into commercially available EMR. While comparative effectiveness data surrounding EMR-based clinical decision-making interventions are limited, ongoing prospective trials will help clarify the clinical utility of these techniques.

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