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The changing characteristics of atrial fibrillation patients treated with warfarin

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Abstract

It has been suggested that direct oral anticoagulants are being preferentially used in low risk atrial fibrillation (AF) patients. Understanding the changing risk profile of new AF patients treated with warfarin is important for interpreting the quality of warfarin delivery through an anticoagulation clinic. Six anticoagulation clinics participating in the Michigan Anticoagulation Quality Improvement Initiative enrolled 1293 AF patients between 2010 and 2014 as an inception cohort. Abstracted data included demographics, comorbidities, medication use and all INR values. Risk scores including CHADS₂, CHA₂DS₂-VASc, HAS-BLED, SAMe-TT₂R₂, and Charlson comorbidity index (CCI) were calculated for each patient at the time of warfarin initiation. The quality of anticoagulation was assessed using the Rosendaal time in the therapeutic range (TTR) during the first 6 months of treatment. Between 2010 and 2014, patients initiating warfarin therapy for AF had an increasing mean CHADS₂ (2.0 ± 1.1 to 2.2 ± 1.4 , $p = 0.02$) and CCI (4.7 ± 1.8 to 5.1 ± 2.0 , $p = 0.03$), and a trend towards increasing mean CHA₂DS₂-VASc, HAS-BLED, and SAMe-TT₂R₂ scores. The actual TTR remained unchanged over the study period (62.6 ± 18.2 to 62.7 ± 17.0 , $p = 0.98$), and the number of INR checks did not change (18.9 ± 5.2 to 18.5 ± 5.1 , $p = 0.06$). Between 2010 and 2014, AF patients newly starting warfarin had mild increases in risk for stroke and death with sustained quality of warfarin therapy.

Keywords

Atrial fibrillation; Anticoagulation; Warfarin

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Background

Ischemic stroke is a common and highly mortal complication of atrial fibrillation (AF) [1, 2]. Oral anticoagulant use decreases the risk of ischemic stroke, especially in higher risk patients [3–5]. Until recently, warfarin has been the primary oral anticoagulant used for stroke prevention in AF patients. Newly available direct oral anticoagulants (DOACs) have been shown to be at least as effective as warfarin for stroke prevention in AF [6–9]. Unlike warfarin, DOAC medications have the distinct advantages of not requiring routine blood monitoring and have a rapid onset. The use of DOACs has risen dramatically over the past several years, accounting for up to 60 % of new anticoagulation prescriptions in 2013 [10, 11].

It has been suggested that lower risk patients are preferentially prescribed DOACs while higher-risk patients are more commonly prescribed warfarin. This may be because physicians feel more comfortable prescribing anticoagulants with no known reversal agent to patients with lower baseline risk of bleeding and stroke [11, 12]. If more low risk patients with AF are being started on DOACs, it is unclear exactly how the population of patients who remain on warfarin will impact the quality of anticoagulation delivered by anticoagulation clinics. Anticoagulation clinics utilize the time in therapeutic range (TTR) metric to track the quality of warfarin care delivered because this metric is predictive of stroke and bleeding events [13]. Studies have shown that AF patients with more comorbid disease have a lower TTR [14]. If higher risk AF patients being initiated on warfarin are found to have a lower TTR, anticoagulation clinics would need to find ways to further ameliorate the effects of comorbid disease and/or reconsider the cutoff for an acceptable TTR.

We hypothesize that patients newly initiating warfarin for stroke prevention in AF are at higher risk of stroke and bleeding, based on standardized risk models, since the introduction of DOAC medications and that this change is associated with decreasing quality of warfarin care at anticoagulation clinics. To test this hypothesis, we explored the characteristics of new warfarin patients referred to six diverse anticoagulation clinics in Michigan since 2010. We also assessed the quality of warfarin care for these patients, as measured by the TTR during the first 6 months of anticoagulation.

Methods

MAQI² collaborative

The Michigan Anticoagulation Quality Improvement Initiative (MAQI²) is a quality improvement consortium sponsored by Blue Cross Blue Shield of Michigan/Blue Care Network (BCBSM/BCN). Full details of the MAQI² consortium have previously been published [15]. The MAQI² goals include describing anticoagulation care across the state of Michigan, identifying predictors of various outcomes, and collaborating on quality improvement projects. MAQI² was formed in 2008 and started enrolling patients in 2009. Six anticoagulation clinics in the state of Michigan are currently participating. The clinics are reimbursed by BCBSM/BCN for the costs incurred by participating in the collaborative,

including the cost of data abstraction. Data abstractors are trained and each clinic is audited to ensure high quality data collection.

Patient selection

Between January 2010 and June 2014, patients with AF treated with warfarin and followed at one of the six anticoagulation clinics participating in MAQI² were eligible for this study. In an effort to limit the number of patient charts continually abstracted, beginning in 2011 new patients were randomly selected for enrollment into MAQI² only when prior MAQI² patients discontinued therapy. For that reason, yearly totals do not reflect total clinic enrollment volumes, but rather a representative sample of warfarin-treated patients at these six centers. Patients included in this study were initiated on warfarin therapy within 2 weeks of anticoagulation clinic enrollment at a participating MAQI² center. Exclusion criteria included those switched to a non-warfarin anticoagulant alternative, patients with any other indication for warfarin (e.g. valve, DVT/PE), patients with less than 6 months of INR follow up, and patients missing a warfarin start date. After the inclusion and exclusion criteria were applied, 1293 patients were included in the study.

Data collection

Demographic and comorbidity data were collected at the time of anticoagulation clinic enrollment and used to calculate the various risk scores, as described below. All INR values were captured and the TTR was calculated using the Rosendaal linear interpolation method for the first 6 months of warfarin therapy [16]. Laboratory values, including renal function, were recorded whenever they were ordered in the medical record during the study period. The estimated creatinine clearance (CrCl) was calculated using the Cockcroft-Gault equation [17].

Estimates of stroke and bleeding risk

To estimate stroke risk in non-valvular AF patients, the CHADS₂ and CHA₂DS₂-VASc scores were calculated. The CHADS₂ was calculated by giving one point each for a history of heart failure, hypertension, age ≥ 75 years and diabetes mellitus. Two points are given for a history of stroke or transient ischemic attack [18]. The CHA₂DS₂-VASc was calculated by giving one point each for history of heart failure, hypertension, diabetes, vascular disease history, age between 65 and 74, and female sex. Two points are given for age ≥ 75 and for history of stroke, TIA or thromboembolism [19].

To estimate bleeding risk in non-valvular AF patients, the HAS-BLED score was calculated by giving one point each for a history of hypertension, abnormal renal function (defined as CrCl <50 mL/min), a history of chronic liver disease, a history of stroke or transient ischemic attack, prior major bleeding events, elderly (age >65 years), a history of anti-platelet medications and a history of alcohol abuse [20]. Since the HAS-BLED score was calculated at the time of warfarin initiation, the labile INR variable was not included.

Estimation of INR control

To predict the quality of INR control, the SAME-TT₂R₂ score was calculated [14, 21]. One point was given for female sex, age <60 years, medical history (2 of the following:

hypertension, diabetes, coronary artery disease/myocardial infarction, peripheral arterial disease, congestive heart failure, previous stroke, pulmonary disease, hepatic or renal disease) and treatment (interacting drugs, e.g. amiodarone for rhythm control). Two points were given for tobacco use and race (non-Caucasian). A low score (0–2) has been showed to correlate with good INR control (TTR 70 %) while a higher score (>2) predicts poorer anticoagulation control.

Charlson comorbidity index

The CCI is a well-validated tool that uses comorbid medical conditions to predict mortality [22, 23]. To calculate the CCI, one point was given for a history of myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, diabetes mellitus, and liver disease. Two points were given for diabetes mellitus with comorbidities (e.g. coronary artery disease, prior stroke, peripheral artery disease and chronic kidney disease), moderate to severe chronic kidney disease as determined by CrCl <60 mL/min, leukemia and solid tumor [24]. We were unable to include dementia, COPD, connective tissue disease, peptic ulcer disease, hemiplegia, leukemia, malignant lymphoma, AIDS and the severity of liver disease in our calculation of the CCI since these variables were not collected on the standardized data form.

Study endpoints

The co-primary endpoints were the change in stroke and bleeding risk scores (CHADS₂, CHA₂DS₂-VASc and HAS-BLED) between 2010 and 2014. Secondary endpoints included the TTR during the first 6 months of anticoagulation, SAME-TT₂R₂ and the CCI scores, the number of INR checks during the first 6 months of anticoagulation, whether renal function changed significantly over time, and the change in insurance status from 2010 to 2014. Selected components of the SAME-TT₂R₂ score (sex, age and race) were also analyzed individually.

Statistical analysis

Patient demographics and comorbidities are described using Fisher's exact, Cochran–Armitage Trend tests, linear and logistic regression analysis. A 2-sided $p < 0.05$ was considered statistically significant for all analyses. Given that anticoagulation data was compiled from six separate anticoagulation clinics, the p-values were adjusted to account for the clustering. All analyses were performed with statistical software SAS 9.3 (Cary, North Carolina, USA).

Results

Among the 1293 AF patients included in this analysis between 2010 and 2014, the mean CHADS₂ score increased from 2.0 ± 1.1 to 2.2 ± 1.4 ($p = 0.02$) and mean CCI increased from 4.7 ± 1.8 to 5.1 ± 2.0 ($p = 0.03$; Table 1). The mean CHA₂DS₂-VASc score increased from 3.5 ± 1.6 to 3.7 ± 1.7 ($p = 0.08$) and the HAS-BLED score increased from 2.7 ± 1.2 to 3.0 ± 1.3 ($p = 0.08$; Table 1).

Despite the increase in stroke risk and CCI score, the mean SAME-TT₂R₂ did not increase significantly over the study period (2.2 ± 1.4 to 2.5 ± 1.5 ; $p = 0.16$; Table 1, Fig. 1). Similarly, the mean TTR during the first 6 months of anticoagulation did not decrease between 2010 ($62.6 \pm 18.2\%$) and 2014 ($62.7 \pm 17.0\%$; $p = 0.98$; Fig. 1). The mean number of INR checks over the first 6 months of anticoagulation did not change meaningfully between 2010 (18.9 ± 5.2) and 2014 (18.8 ± 5.1 , $p = 0.06$; Table 2).

The mean CrCl did not change between 2010 (81.9 ± 46.3 mL/min) and 2014 (81.8 ± 38.2 ; $p = 0.73$). The mean age at warfarin initiation remained stable (71.1 ± 12.2 to 71.3 ± 11.7 ; $p = 0.77$). There was no significant change in gender distribution between 2010 (56.6 % male, 43.4 % female) and 2014 (58.3 % male, 41.7 % female; $p = 0.31$). Less than 1 % of patients included in the study did not have insurance.

Discussion

Between 2010 and 2014, there was a small increase in stroke risk and the CCI in AF patients newly initiated on warfarin therapy and referred to one of six diverse anticoagulation clinics. Despite the slightly higher risk patient population, the predicted and actual quality of warfarin therapy, as measured by the SAME-TT₂R₂ and TTR, respectively, remained stable during the four-year study period.

Our study supports the idea that in 2014, higher-risk patients are being preferentially treated with warfarin for stroke prevention in AF. While we have not assessed the risk profile of DOAC-treated AF patients, other studies have described this finding [11, 12]. Patients with lower bleeding and stroke risk scores might be perceived as better candidates to receive anticoagulants for which reversal agents do not currently exist.

Our study was unable to find a correlation between higher risk AF patients, as estimated by the CHADS₂ score and CCI, and poorer quality warfarin care. However, given the small but significant changes in mean CHADS₂ and CCI scores, we are unable to draw conclusions about larger changes in CHADS₂ or CCI scores and a change in TTR. Despite the increasing stroke risk described by the CHADS₂ score, a tool developed specifically for predicting the quality of warfarin care did not increase in our cohort. This newer risk assessment tool, the SAME-TT₂R₂ score, has a non-significant increase in our cohort over the study period. Previous studies have associated a higher SAME-TT₂R₂ score with lower quality warfarin care, as measured by the TTR [21]. In our cohort, there was no statistically significant rise in either the SAME-TT₂R₂ score or the actual TTR over the first 6 months of therapy in this population. In other words, the patients in the MAQI² database are at a modestly higher risk of stroke according to CHADS₂ scores, but they are not receiving inferior anticoagulation when compared with previous groups of warfarin-anticoagulated patients. Our study, along with numerous other reports, suggests that prediction of a specific outcome is best done through specific prediction tools [25–27]. In this case, to predict the quality of warfarin care, it is best to use the SAME-TT₂R₂ score and not the CHADS₂, CHA₂DS₂-VASc or HAS-BLED score.

This study's design has a number of important strengths. First, all data was gathered from chart abstraction and random audit instead of using claims-based data. Using trained abstractors familiar with the anticoagulation clinic model to abstract the data ensures the highest-quality data, including accurate comorbidity assessment and laboratory value reporting. Additionally, our study examined an inception cohort of patients newly initiation warfarin therapy for stroke prevention in AF. This prevents any potential selection bias from warfarin-experienced patients who tend to have higher TTRs when warfarin is restarted [28]. Lastly, this study examines patients for whom the decision between warfarin and a DOAC is most applicable.

This study's findings have to be interpreted along with certain limitations. First, as with all observational studies, concerns exist regarding the generalizability of these findings. However, the MAQI² registry comprises a heterogeneous group of patients at six diverse anticoagulation clinics in Michigan representing large and small anticoagulation clinics affiliated with academic and private practices located in urban, suburban and rural locations. Second, some of our risk stratification scores required modification because not all data elements were available in the MAQI² database. The CCI, for example, takes into account several other comorbidities like dementia, COPD, connective tissue disease, peptic ulcer disease, hemiplegia, leukemia, malignant lymphoma and AIDS, and the severity of liver disease. However, as we have not used the CCI to predict survival, using a modification of the CCI to assess comorbid disease burden has merit [23, 29]. Lastly, further changes in the adoption of DOACs may have future impact on the types of patients treated with warfarin. Those changes in practice pattern would need to be assessed in future studies.

In summary, AF patients initiated on warfarin therapy between 2010 and 2014 had increasing stroke risk and CCI scores. Despite having higher risk profiles, the quality of anticoagulation measured by TTR remained unchanged between 2010 and 2014. Our study highlighted the importance of using dedicated risk tools (e.g. SAME-TT₂R₂) and not stroke-risk tools to predict the quality of anticoagulation care.

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Fig. 1. SAME-TT₂R₂ and TTR during first 6 months of anticoagulation. *TTR* Time in therapeutic range

Table 1

Demographic data and risk scores by year

	2010 N = 525 (40.6 %) N (%)	2011 N = 304 (23.5 %) N (%)	2012 N = 193 (14.9 %) N (%)	2013 N = 199 (15.4 %) N (%)	2014 N = 72 (5.6 %) N (%)	p value
Age at warfarin start						
Mean ± SD	71.7 ± 12.2	73.1 ± 11.2	72.7 ± 11.7	71.9 ± 11.7	71.3 ± 10.7	0.77
Gender						
Male	297 (56.6)	165 (54.3)	107 (55.4)	96 (48.2)	42 (58.3)	0.31
Female	228 (43.4)	139 (45.7)	86 (44.6)	103 (51.8)	30 (41.7)	
Race						
White	450/513 (87.7)	264/290 (91.0)	166/184 (90.2)	166/188 (88.3)	57/61 (93.4)	0.62
AA	46/513 (9.0)	22/290 (7.6)	13/184 (7.1)	18/188 (9.6)	2/61 (3.3)	
Other	17/513 (3.3)	4/290 (1.4)	5/184 (2.7)	4/188 (2.1)	2/61 (3.3)	
Type of insurance						
Commercial insurance	183/515 (35.5)	102/297 (34.3)	87/187 (46.5)	71/199 (35.7)	21/71 (29.6)	0.73
Medicare	325/515 (63.1)	184/297 (62.0)	99/187 (52.9)	122/199 (61.3)	46/71 (64.8)	0.39
Medicaid	5/515 (1.0)	8/297 (2.7)	1/187 (0.5)	4/199 (2.0)	2/71 (2.8)	0.33
Risk scores (Mean ± SD)						
CHADS ₂	2.0 ± 1.1	2.0 ± 1.1	2.0 ± 1.2	2.2 ± 1.3	2.2 ± 1.4	0.02
CHA ₂ DS ₂ -VASc	3.5 ± 1.6	3.6 ± 1.6	3.5 ± 1.6	3.9 ± 1.9	3.7 ± 1.7	0.08
HAS-BLED	2.7 ± 1.2	2.8 ± 1.1	2.7 ± 1.1	2.8 ± 1.3	3.0 ± 1.3	0.08
SAME-TT ₂ -R ₂	2.2 ± 1.4	2.3 ± 1.3	2.1 ± 1.3	2.4 ± 1.4	2.5 ± 1.5	0.16
Charlson comorbidity index	4.7 ± 1.8	4.9 ± 1.6	4.9 ± 1.8	5.0 ± 1.9	5.1 ± 2.0	0.03

SD Standard deviation, AA African American

Table 2

Measured TTR and number of INR checks in the first 6 months of anticoagulation

	2010	2011	2012	2013	2014	p value
TTR in first 6 months of anticoagulation	62.6 ± 18.2	63.2 ± 18.2	64.6 ± 18.2	61.6 ± 18.5	62.7 ± 18.8	0.98
# INR checks in first 6 months	Mean ± SD	18.9 ± 5.2	18.3 ± 5.8	17.0 ± 5.4	18.2 ± 6.1	18.8 ± 5.1
						0.06

TTR Time in therapeutic range, INR international normalized ratio, SD standard deviation