

BMJ Open A non-experimental study of oral anticoagulation therapy initiation before and after national patient safety goals

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ABSTRACT

Objectives: The Joint Commission revised its National Patient Safety Goals (NPSGs) to include oral anticoagulation therapy (OAT) in 2008. We sought to examine the effect of including OAT in The Joint Commission's NPSGs on historically low rates of OAT initiation for individuals with incident atrial fibrillation (AF).

Setting: Southeastern state in the USA.

Participants: North Carolina State Health Plan claims data from 944 500 individuals enrolled between 1 January 2006 and 31 December 2010, supplemented with data from the Area Resource File and Online Survey, Certification and Reporting data network. We evaluated OAT initiation before and after the 2008 NPSGs revisions in a retrospective cohort new user design with an AF intervention group and two control groups: a positive control—patients estimated to be at very high risk of thromboembolism (mechanical heart valve and pulmonary embolism); and a negative control—patients with very low perceived risk of thromboembolism (paroxysmal AF). We developed multivariable models using a difference-in-difference parameterisation. Effects were estimated with generalised estimating equations.

Primary outcome measure: OAT initiation, a binary outcome defined as having a prescription drug claim for warfarin within 30 days of the index claim.

Results: OAT initiation was low (26.8%) for eligible individuals with incident AF in 2006–2008 but increased after NPSGs implementation (31.7%, $p=0.022$). OAT initiation was high but decreased in the positive control group (67.5% vs 62.0%, $p=0.003$). Multivariate analysis resulted in a relative 11% (95% CI (4% to 18%), $p<0.01$) increase in OAT initiation for incident AF patients.

Conclusions: We document a substantial increase in guideline concordant OAT initiation in incident AF after the establishment of NPSGs, suggesting that regulatory healthcare agency initiatives can influence clinical practice.

BACKGROUND

Oral anticoagulation therapy (OAT) to reduce acute ischaemic stroke risk in patients with moderate-risk or high-risk atrial

Strengths and limitations of this study

- Privately insured cohort with 5 years claims data, extensive control variables and two control groups.
- Claims analysis; lacks individual race/ethnicity and socioeconomic status information; may not generalise to public insurance programmes (eg, Medicaid and Medicare).
- Non-experimental, pre–post two-group comparison design means that results cannot be interpreted as causal.

fibrillation (AF), typically with warfarin, has been recommended by guidelines from major organisations for nearly two decades.¹ However, despite its benefit, OAT is often underutilised among eligible patients with AF.^{2–8} Underutilisation may result from patient, physician and/or healthcare system factors.^{9–15}

The Joint Commission is the nation's oldest and largest standards-setting and accrediting body in healthcare. Its primary purpose is to¹⁶: “continuously improve healthcare for the public, in collaboration with other stakeholders, by evaluating healthcare organisations and inspiring them to excel in providing safe and effective care of the highest quality and value”. To this end, the Joint Commission evaluates and accredits more than 19 000 healthcare organisations and programmes in the USA. The Joint Commission accreditation is required for reimbursement from Medicare and many private health insurance companies. The Joint Commission established a National Patient Safety Goals (NPSGs) programme in 2002 to help accredited organisations address specific patient safety concerns. To oversee this task, it established the Patient Safety Advisory Group, a panel of nurses, physicians, pharmacists, risk managers, clinical engineers and other professionals who



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have hands-on experience in addressing patient safety issues in a wide variety of healthcare settings. This panel continuously evaluates and updates NPSGs to identify, prioritise and help address a broad range of emerging patient safety issues.

In 2008, the NPSGs were updated to include goals regarding OAT. The NPSGs concerning anticoagulation (specifically, NPSG 03.05.01) represent a change in the external environment, or natural experiment, intended to affect the healthcare system, most notably hospitals. They do not mandate that all eligible patients receive anticoagulation, but rather provide explicit guidelines and expectations for hospitals that provide anticoagulation therapy and/or long-term OAT to reduce the likelihood of patient harm associated with these therapies.

Achieving compliance with NPSGs may be moderated by a hospital's pre-existing resources and practice norms, as well as their willingness to invest in the infrastructure required to meet them. Hospitals with sufficient resources may be in compliance with regulatory requirements before or soon after they are established. Hospitals with fewer resources may take longer to become compliant with new regulatory requirements or attempt to avoid them altogether. In the case of OAT, hospitals may invest in resources to provide long-term outpatient management and monitoring for patients receiving OAT, for example, anticoagulation clinics. Providing anticoagulation clinics is thought to increase OAT initiation and OAT quality as community admitting physicians may be more likely to initiate OAT due to hospital regulatory requirements and the availability of additional resources to manage and monitor anticoagulation.^{14 17}

However, hospitals may instead opt to minimise use of anticoagulants, discontinue anticoagulation clinics and elect not to initiate OAT in eligible patients, in the hope of avoiding increasing regulatory oversight and burden of compliance. In this case, hospital actions negatively influence OAT initiation via establishing clinical inertia (eligible patients often start OAT as inpatients) and the NPSGs (intended to prevent harm) may have an unintended effect in reducing OAT initiation for eligible patients. The precedent of newly developed policy achieving its proximal intended effects while creating larger downstream unintended effects is well-established. For example, pay-for-performance and organisational quality reporting initiatives have been met with unintended consequences in the experience of several countries.^{18–21} This can include unintended consequences of increased healthcare costs,²² reduced quality of unreported care²¹ and lower quality care among highest risk patients.^{18 20} Similarly, public reporting of outcomes data by provider for cardiac surgery in New York state led to subsequent high-risk patient aversion and higher cardiac surgery mortality rates in neighbouring states.²³ Finally, the Center for Medicare and Medicaid Services (CMS) recently implemented a policy to withhold payment to hospitals for certain avoidable adverse events has also resulted in unintended consequences.²⁴

Although the implementation of NPSGs is intended to improve healthcare quality (especially process-oriented measures), the Joint Commission's prior initiatives have had mixed success. For example, compliance with the Joint Commission guidelines for discharge instructions in patients with heart failure was associated with decreased readmission rates.²⁵ Similarly, a positive relationship between adherence to the Joint Commission heart failure core measures and 1-year survival has been reported.²⁶ However, other studies found no association between adherence to the Joint Commission heart failure core measures and mortality or readmission at 60–90 days or at 1 year.^{27 28}

We sought to determine the effect of the Joint Commission's anticoagulation NPSGs on OAT initiation. We hypothesised the NPSGs would increase OAT initiation among eligible patients hospitalised with incident AF, but were keenly aware of the potential unintended negative influence of the NPSGs on OAT initiation. We also conducted sensitivity analyses to examine potential indirect effects of the NPSGs.

METHODS

Data sources

We used data from 1 January 2006 to 31 December 2010 from the North Carolina State Health Plan (NCSHP), a large self-funded insurance plan for the study. The NCSHP, administered by Blue Cross and Blue Shield of North Carolina, includes almost 700 000 state employees, teachers, retirees and their dependents at any given time and approximately one million individuals are included in the 5-year study window. Approximately 10% of enrollees are retired non-Medicare participants, and 16% are retired Medicare beneficiaries. This claims structured database contains inpatient, outpatient and pharmacy records. Enrollee descriptors include unique encrypted member identification numbers, basic demographic information including age, gender, county and Zone Improvement Plan (ZIP) code of primary residence. Records include information about diagnoses, procedures, providers, charges and payments. The database also contains physician level characteristics which include provider ZIP code, type of provider and provider specialty if applicable. We linked the NCSHP database to hospital facility characteristics including accreditation as a primary stroke centre, hospital bed size and participation in a stroke quality improvement programme. Finally, we linked individual and facility counties with variables from the Area Resource File to concurrently analyse healthcare delivery at the patient, provider, hospital facility and county levels.

Cohort selection rationale

Our goal was to create three cohorts with varying levels of thromboembolism risk without receipt of OAT. Specifically we sought to create perceived high, medium and low thromboembolism risk cohorts, with the intent

to use the high-risk and low-risk cohorts as positive and negative control groups, respectively. The incidence of thromboembolism in patients with mechanical heart valves is 4.4/100 patient-years without anticoagulation and 1.0/100 patient-years with warfarin.²⁹ Although the attributable risk of AF to ischaemic stroke increases dramatically with increasing age, the overall relative risk is approximately fivefold higher for ischaemic stroke among patients with AF.³⁰ Including all ages, the average annual risk of ischaemic stroke for individuals with AF is 2–4% per year (2–4 per 100 patient-years).²⁹ OAT reduces this risk by 64%.³¹ Historically paroxysmal (intermittent) AF has been considered a lower risk for ischaemic stroke than mechanical heart valves and chronic AF.^{32–33} However, a signal of equivalent ischaemic stroke risk was apparent as early as 2000 in the Stroke Prevention in AF trial.³⁴ Yet despite others confirming the elevated risk associated with paroxysmal AF,^{32–35} major guidelines for primary prevention of stroke were not changed to include OAT for paroxysmal AF until 2006.²⁹ Thus our inclusion of paroxysmal AF as a negative control group is based on historically perceived risk rather than actual risk of ischaemic stroke.

Study sample

We created three cohorts: (1) patients with new onset AF; (2) positive control patients who are estimated to be at high risk of thromboembolism (mechanical heart valve or significant venous embolism) and (3) negative control patients, often mistakenly perceived to have a very low risk of thromboembolism (paroxysmal AF). For all three cohorts, patients needed to be continuously enrolled in the NCSHP a minimum of 6 months prior to and 6 months following the qualifying index claim. Individuals with a prescription claim for warfarin more than 30 days prior to an index claim for any of the three cohorts were excluded due to a high probability of representing prevalent rather than incident conditions. **Figure 1** provides a summary of cohort identification and determination of eligibility. Eligibility criteria for each cohort are described below.

Patients with new onset AF: We used either one inpatient diagnosis or two outpatient diagnoses within 12 months (International Classification of Disease 9th edition-Clinical Modification (ICD-9-CM) code 427.31) to identify individuals with AF. We designated the first

outpatient AF claim or hospital admission as the date of entry into the cohort. The American College of Cardiology, the American College of Chest Physicians and the American Heart Association endorse the use of a risk-based score to identify individuals who will benefit from receiving OAT. CHADS2 is a commonly employed scoring system.³⁶ Individuals receive one point for congestive heart failure, hypertension, age >75 years, and diabetes mellitus; they receive two points for any prior stroke or stroke symptoms. CHADS2 scores are readily generated using claims data (see web-only table A.1 for ICD-9-CM codes for these diagnoses). Based on current recommendations,³¹ we included all individuals meeting criteria for incident AF with a CHADS2 score ≥ 2 . To increase the precision of our estimates, we used ICD-9-CM codes to exclude individuals with ≥ 1 relative contraindication to OAT from the incident AF or intervention cohort (see web-only table A.2 for contraindications and ICD-9-CM codes). Finally, to reduce the probability of including individuals with prevalent, rather than incident, AF, we excluded individuals with any AF-related claim in the 6 months preceding the index claim.

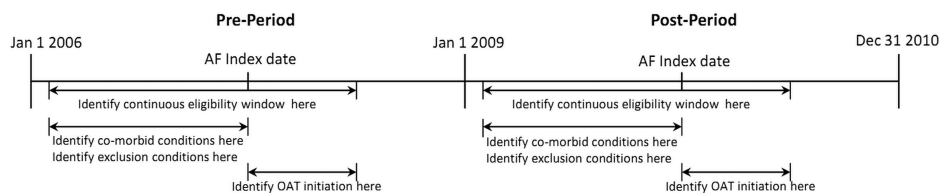
Perceived very high-risk patients (positive controls): this cohort includes individuals with either one inpatient diagnosis or two outpatient diagnoses within 12 months indicating a mechanical heart valve or significant thromboembolism (see web-only table A.3 for diagnoses and ICD-9-CM codes). The CHADS2 score was not applied to this cohort, as it is only validated in patients with AF. Finally, to reduce the probability of including individuals with prevalent conditions rather than incident mechanical heart valves or significant thromboembolism, we excluded individuals with any condition-related claim in the 6 months preceding the index claim.

Perceived low-risk patients (negative controls): individuals with either one inpatient diagnosis or two outpatient diagnoses within 12 months for paroxysmal AF (ICD-9-CM code 427.21) were included in the negative control cohort.

Measures

The primary dependent variable is OAT initiation, a binary outcome defined as having a prescription drug claim for warfarin within 30 days of the index claim. Index claims occurring in years 2006–2008 were

Figure 1 Selection of incident atrial fibrillation (AF), application of inclusion/exclusion criteria and identification of comorbid conditions. Key aspects of defining eligibility period, measurement of comorbid conditions and measurement of oral anticoagulation therapy (OAT) initiation are shown above.



categorised as pre-NPSGs; index claims in 2009–2010 were assigned post-NPSGs status. The key explanatory variable is the interaction term between a binary indicator for prestatus/poststatus of the Joint Commission's NPSGs and a binary indicator variable for the incident AF cohort, which represents the difference-in-difference estimator. The difference-in-difference estimator is the pre–post difference in the treatment (AF cohort) group minus the pre–post difference in the control group (positive control cohort).

Control variables were created at the patient, county and facility levels. All control variables were identified a priori and measured in the baseline period or immediately prior to the index AF claim to mitigate potential confounding. Patient-level control variables include age, gender, Charlson Comorbidity Index,^{37 38} CHADS2 score, rurality/urbanicity of residence, and number of outpatient visits to a primary care provider in the 30 days prior to the index claim. The Charlson Comorbidity Index, a widely used measurement of patient comorbidities, was categorised as 0, 1, 2, 3–4 and ≥ 5 . CHADS2 score was categorised as 2, 3–4 and ≥ 5 . Rurality/urbanicity of residence was categorised into rural, micropolitan or metropolitan as defined by the Area Resource File.³⁹

County-level control variables included: race and ethnicity demographics, unemployment rate, per cent of persons below poverty line, median household income, a rolling 3-year average number of deaths from cerebrovascular disease, number of general practitioners and number of cardiovascular subspecialists in county, which were extracted from the Area Resource File.³⁹

We specifically included several facility-level variables that were anticipated to have substantial influence in OAT initiation rates. These facility level control variables included: hospital primary stroke centre accreditation status as defined by CMS (binary variable for each time period); participation in 'Get with the Guidelines Stroke:' Program or North Carolina Stroke Care Collaborative, stroke care quality improvement programmes that include AF and OAT (binary variable for each time period); distance of hospital from enrollee residence; hospital bed size and rural/urban facility location. Get with the Guidelines Stroke participation was determined from the American Heart Association website (<http://www.heart.org>). Participation in the North Carolina Stroke Care Collaborative was provided by the organisation. We calculated distance as the straight line distance from the centroid of patient and hospital ZIP codes using SAS V.9.2. Hospital bed size was determined from the Online Survey, Certification and Reporting (OSCAR) data network maintained by the CMS.

Statistical analysis

We examined cohorts for differences in baseline covariates as well as differences within cohorts between preperiod and postperiod. Unadjusted rates of OAT initiation for each cohort were also examined. We then estimated

the association between NPSGs and initiation of OAT among individuals with new onset AF using a difference-in-difference approach and multivariable regression equations. Differences in OAT initiation before and after the policy change for the control groups are attributed to a time effect. Subtracting the pre–post difference in the positive control cohort from the pre–post difference in the AF (treatment) cohort yields an estimate that is more robust to external factors and time effects. In practice the difference-in-difference estimate is created by interacting the treatment (in this case time) variable with a dummy variable indicating the treatment cohort. Thus we model the probability of OAT initiation using a log-Poisson model specified as:

$$\Pr(\text{OAT}_{\text{ift}} = 1 | \mathbf{X}_{\text{ift}}) = \log \mathbf{X}\beta \quad (1)$$

with

$$\mathbf{X}\beta = \beta_0 + \beta_1 \text{AF}_i + \beta_2 \text{Post}_i + \beta_3 (\text{AF}_i \times \text{Post}_i) + \beta_4 \mathbf{X}_i$$

where i indicates the individual, OAT is the outcome variable, AF represents the cohort and Post indicates whether the index claim occurred pre (Post=0) or post (Post=1) NPSGs implementation, and \mathbf{X} is a vector of individual patient and facility control variables defined above. Facility level fixed effects are taken into account by clustering within facilities using the administrative hospital identification number and specifying an exchangeable within-group correlation structure. The coefficient that identifies the effect of interest is β_3 , which estimates the effect of NPSGs on the probability of OAT initiation for patients with incident AF.

We estimated the parameters in the above model robustly using generalised estimating equation (GEE) methods in which we specified a Poisson error distribution. To account for within hospital correlation (eg, observations within hospital are not completely independent observations) we clustered on administrative hospital identification number by specifying the cluster variable during fitting of the GEE model and assumed an exchangeable within-group working correlation structure.⁴⁰ Robust (sandwich estimation) SEs were estimated during model fitting, to account for underdispersion of the binary dependent variable in the context of a count distribution.⁴¹ We converted the coefficients to average marginal effects as absolute risk differences for ease of interpretation. All models were estimated in Stata V.11 (StataCorp, College Station, Texas, USA).

We conducted several sensitivity analyses. The first assessed potential measurement error in OAT initiation. The rise of many low-cost generic prescription drug programmes administered through major retailers has caused concern regarding under identification of generic drugs within pharmacy claims data.^{42 43} Warfarin has been generic for several decades, and multiple generic formulations exist. While a claim for warfarin is specific for OAT initiation, it may be lacking

somewhat in sensitivity. We created two alternative definitions for OAT initiation using claims for laboratory blood tests associated with blood coagulation or anticoagulation management claims (see web-only table A.4 for Current Procedural Terminology (CPT) codes and ICD-9-CM codes employed). The laboratory blood tests were hypothesised to represent a sensitive measure of OAT initiation that might have less specificity for OAT initiation as it is associated with the monitoring of the effect of warfarin, but is not specific to anticoagulation management alone.

The first alternative definition for OAT initiation combined: a pharmacy claim for warfarin; a claim for associated laboratory blood tests or a claim for OAT management. The second alternative definition excluded the pharmacy claim, utilising only the laboratory blood test and OAT management claims to define initiation. The next sensitivity analysis compared the effect of the policy on an inpatient only cohort (hypothesised to demonstrate the greatest effect), an outpatient only cohort, and a combined inpatient and outpatient cohort. The final set of sensitivity analyses involved an extensive evaluation of non-linear effects of included model covariates and additional county level covariates that could be hypothesised to affect the observed relationship between the policy change and observed OAT initiation rates.

RESULTS

Descriptive findings

We identified 2021 individuals for the AF cohort; 2708 individuals for the positive control cohort; and 606 individuals for the negative control cohort (table 1). Both control groups exhibited a decrease in proportion initiating OAT while the eligible AF cohort exhibited an increase (0.268 vs 0.317). The relative OAT initiation pre-post difference (change in intervention minus change in control) for the eligible AF cohort was 0.104 and 0.081 in comparison to the positive and negative controls, respectively. OAT initiation in the AF group (26.8%) was within range of previous observational studies.⁴⁴

Within specific cohorts, age remained stable while comorbidities increased in the postperiod (table 2). In all cohorts, there was a marked increase in the

percentage of individuals treated in hospitals that were accredited primary stroke centres or participating in a quality improvement programme for acute stroke care. County level characteristics generally remained stable from the preperiod to postperiod. Two notable exceptions to this trend were average unemployment rate and per cent of persons in poverty, which increased in all cohorts from the preperiod to postperiod. Similarly, median household income fell in the postperiod for all cohorts.

The county level race and ethnicity demographics remained stable across time for all cohorts.

Regression results

The marginal effect for the interaction term between the AF cohort and the postperiod represents the difference-in-difference estimate (table 3). Compared with the positive control cohort, the OAT initiation rate increased on average 10-percentage points ($p<0.01$) for the AF cohort in the postperiod. Controlling for patient and hospital facility characteristics, this increase in OAT initiation remained significant (11-percentage point increase, $p<0.01$). Compared to the positive control cohort, the rate of OAT initiation was not significantly different in the negative control cohort. Oldest individuals (≥ 71 years) and those with the highest number of comorbid conditions were less likely to initiate OAT. Being at greater risk of acute ischaemic stroke (by CHADS2 score) was not associated with greater OAT initiation. Greater number of outpatient primary care physicians claim preceding entry into the cohort was associated with increased OAT initiation. Finally, residential distance from the admitting hospital was negatively associated with OAT initiation.

Sensitivity test results

In sensitivity analyses (table 4), the difference-in-difference estimate for the AF group was robust to alternate definitions of OAT initiation. The combined pharmacy claims, blood laboratory test and anticoagulation management definition of OAT initiation yielded a similar marginal effect of a nine-percentage point increase ($p<0.05$) in OAT initiation for the treatment group compared with the positive control cohort in the postperiod. The marginal effect was smaller and non-significant in the blood laboratory test and

Table 1 Proportion of cohort initiating oral anticoagulation therapy in preperiod and postperiod

Cohort	Preperiod		Postperiod		Difference	p Value
	N	Proportion	N	Proportion		
Eligible AF	1359	0.268	662	0.317	0.049	0.022
Positive control	1597	0.675	1111	0.620	-0.055	0.003
Negative control	302	0.238	204	0.206	-0.032	0.398
Difference-in-difference estimate (AF-positive control)					0.104	
Difference-in-difference estimate (AF-negative control)					0.081	

AF, atrial fibrillation.

Table 2 Baseline characteristics among intervention group and control groups

Variable	Preperiod			Postperiod		
	Eligible AF	Mechanical heart valve (+ control)	PAF (– control)	Eligible AF	Mechanical heart valve (+ Control)	PAF (– Control)
Sample size	1359	1597	302	662	1111	204
Patient characteristics						
Age	77.9 (11.2)	65.0 (15.7)	71.2 (12.9)	76.7 (11.3)	65.4 (15.3)	70.6 (12.6)
Male	40.5	41.3	53.3	38.7	40.8	57.4
Rural	9.7	10.2	9.3	12.3	10.5	11.8
CHF	29.7	18.8	32.5	23.0	27.1	34.3
Hypertension	94.7	68.1	82.8	96.2	76.8	85.8
Diabetes mellitus	45.3	26.5	39.4	45.5	35.2	39.7
Ischaemic stroke	23.7	18.8	21.5	35.5	31.1	29.4
CHADS2 score	2.9 (1.0)	1.8 (1.5)	2.4 (1.5)	3.0 (1.1)	2.3 (1.7)	2.6 (1.6)
Charlson index	2.0 (1.7)	1.4 (1.6)	2.3 (2.0)	2.1 (1.7)	1.9 (2.0)	2.7 (2.3)
Haemorrhagic stroke	0	1.8	0.7	0	1.6	2
Gastrointestinal bleed	0	4.1	2.0	0	8.5	5.4
Falls risk	0	7.5	8.9	0	13.8	7.4
Cirrhosis	0	2.9	2	0	5.3	4.9
Dementia	0	1.8	2.3	0	2.3	2.5
Terminal illness	0	7.4	6.3	0	7.5	6.9
Relative OAT contraindications	0*	0.5 (0.7)	0.4 (0.7)	0*	0.7 (0.9)	0.6 (0.9)
Outpatient visits	3.1 (3.6)	4.1 (6.1)	4.0 (7.2)	3.5 (3.6)	4.8 (5.6)	4.0 (5.5)
Facility characteristics						
Rural hospital	4.7	4.4	2.4	5.8	6.0	3.1
Primary stroke centre	19.2	21.7	31.1	45.8	43.8	50.5
Participates in GWTG	48.6	50.5	47.4	59.2	56.3	63.7
Hospital bed size	449 (311)	464 (309)	525 (322)	461 (307)	460 (310)	506 (324)
Distance residence hospital (miles)	21.7 (82.2)	23.9 (76.7)	22.9 (57.9)	20.1 (48.0)	18.4 (53.4)	18.5 (28.7)
County characteristics						
Caucasian (%)	68.9 (15.3)	68.3 (15.0)	68.5 (14.5)	68.5 (15.1)	68.7 (15.0)	67.6 (15.2)
Per cent African-American (%)	21.4 (13.2)	21.8 (13.2)	21.6 (12.6)	22.0 (13.3)	21.4 (13.3)	22.5 (14.2)
Per cent American Indian	1.4 (5.2)	1.5 (5.2)	1.4 (4.8)	1.3 (4.7)	1.5 (5.1)	1.2 (2.0)
Asian	2.0 (1.9)	2.2 (2.0)	2.2 (2.0)	1.9 (1.9)	2.1 (2.0)	2.2 (2.0)
Hispanic	7.9 (3.6)	8.0 (3.7)	8.0 (3.3)	8.0 (3.7)	8.1 (3.6)	8.3 (4.4)
General practitioners	62.6 (67.8)	68.1 (72.1)	73.5 (76.1)	68.4 (79.8)	73.5 (87.0)	73.6 (80.9)
Cardiovascular specialists	17.0 (21.6)	18.6 (22.9)	20.7 (24.2)	17.6 (23.2)	19.4 (24.8)	19.6 (23.7)
3 year average death cerebrovascular disease	106.5 (90.0)	113.2 (96.8)	119.3 (101.3)	107.0 (91.7)	112.7 (105)	108.7 (93.7)
County Median Hhld income (1000s)	44.6 (9.4)	45.1 (9.6)	46.6 (10.2)	43.5 (9.6)	44.7 (10.0)	44.7 (10.5)
Unemployment rate	5.2 (1.4)	5.4 (1.5)	5.5 (1.7)	10.7 (2.1)	10.7 (2.1)	10.5 (2.3)

*Inclusion in AF treatment group conditional on value of zero for this variable. (), SD.

AF, atrial fibrillation; CHADS2, C—congestive heart failure, H—hypertension, A—>75 years, D—diabetes mellitus, S—prior stroke or stroke symptoms; CHF, congestive heart failure; GWTG, Get With The Guidelines; OAT, oral anticoagulation therapy; PAF, paroxysmal atrial fibrillation.

Table 3 Estimated marginal effects of policy changes, patient characteristics and inpatient facility characteristics on oral anticoagulation therapy initiation

	Adjusted for patient characteristics		Adjusted for patient and facility characteristics	
Adjusted results				
Postperiod	−0.04*	(−0.07 to −0.01)	−0.03*	(−0.06 to −0.00)
Treatment group	−0.39***	(−0.43 to −0.35)	−0.38***	(−0.42 to −0.34)
Negative control	−0.45***	(−0.54 to −0.36)	−0.45***	(−0.54 to −0.36)
Post-treatment	0.10**	(0.04 to 0.17)	0.11**	(0.04 to 0.18)
Post-negative control	−0.03	(−0.19 to 0.13)	−0.03	(−0.19 to 0.13)
Patient characteristics				
18–40 years	0.03	(−0.03 to 0.09)	0.03	(−0.02 to 0.09)
61–70 years	−0.01	(−0.04 to 0.02)	−0.01	(−0.04 to 0.02)
71+ years	−0.10***	(−0.13 to −0.07)	−0.10***	(−0.14, −0.07)
Gender (male)	0.02*	(0.00 to 0.04)	0.03**	(0.01 to 0.05)
Charlson (0)	0.01	(−0.03 to 0.06)	0.01	(−0.03 to 0.05)
Charlson (2)	−0.04*	(−0.07 to −0.00)	−0.04*	(−0.07 to −0.00)
Charlson (3–4)	−0.02	(−0.06 to 0.03)	−0.01	(−0.06 to 0.03)
Charlson (5+)	−0.13***	(−0.17 to −0.09)	−0.12***	(−0.17 to −0.08)
CHADS2 (0–1)	−0.02	(−0.05 to 0.02)	−0.01	(−0.05 to 0.03)
CHADS2(3–4)	−0.05*	(−0.09 to −0.01)	−0.04*	(−0.08 to −0.00)
CHADS2 (5+)	−0.04	(−0.11 to 0.04)	−0.03	(−0.10 to 0.04)
Rural	0.02	(−0.03 to 0.06)	0.01	(−0.05 to 0.07)
Micropolitan	0.01	(−0.03 to 0.04)	−0.00	(−0.05 to 0.04)
0 pre-event visits	−0.05*	(−0.09 to −0.00)	−0.04	(−0.09 to 0.00)
2+ pre-event visits	0.06***	(0.03 to 0.09)	0.05***	(0.02 to 0.08)
Facility characteristics				
Primary stroke centre			−0.01	(−0.06 to 0.04)
GWTC participation			−0.01	(−0.03 to 0.02)
4–99 beds			−0.04	(−0.09 to 0.00)
500+ beds			−0.04	(−0.08 to 0.00)
25+ miles			−0.10***	(−0.16 to −0.05)
Rural provider			0.07	(−0.01 to 0.16)
Micropolitan provider			0.04	(−0.01 to 0.09)
Observations	5235		5235	

95% CIs in parenthesis.

*p<0.05.

**p<0.01.

***p<0.001.

CHADS2, C—congestive heart failure, H—hypertension, A—>75 years, D—diabetes mellitus, S—prior stroke or stroke symptoms, GWTC, Get With The Guidelines

anticoagulation management only definition of OAT initiation. Other associations were similar to that observed in the primary analysis. We also found a strong marginal effect on OAT initiation for an outpatient-only intervention cohort and the combined inpatient–outpatient cohort. Finally, multiple model specifications with alternate functional form and additional control covariates resulted in similar findings as our primary analysis (see web-only table A.5).

DISCUSSION

We examined the association between the Joint Commission revising NPSGs and OAT initiation among privately insured individuals with new onset AF. Compared with the positive control cohort, the revised Joint Commission NPSGs were associated with a 10-percentage point increase in the rate of OAT

initiation among individuals with new onset AF. The negative association between age and OAT initiation as well as number of comorbidities and OAT initiation are consistent with what has been previously described in the literature.⁴⁵ The relative lack of association of increasing CHADS2 scores and OAT initiation is also consistent with prior work and is hypothesised to be secondary to increased comorbidities associated with increasing CHADS2 score that may discourage a clinician from initiating OAT.⁴⁶

The strong positive association between NPSGs and the outpatient cohort in our sensitivity analysis suggest an indirect effect of NPSGs as well. The rate of OAT initiation in the positive control cohort was smaller than anticipated, and decreased between preperiod and postperiod.

The relatively low-OAT initiation in the positive control (perceived very high risk) cohort and the

Table 4 Estimated marginal effects of sensitivity analyses in alternate outcome definitions, outpatient only cohort and combined inpatient/outpatient cohorts

	OAT-RX and OAT-laboratories		OAT-laboratories		OAT-outpatients		OAT-all	
18–40 years	0.01	(−0.04 to 0.07)	0.01	(−0.03 to 0.06)	−0.02	(−0.07 to 0.03)	0.01	(−0.03 to 0.04)
61–70 years	−0.02	(−0.04 to 0.01)	−0.18***	(−0.21 to −0.14)	0.02	(−0.01 to 0.06)	0.01	(−0.02 to 0.04)
71+ years	−0.12***	(−0.16 to −0.09)	−0.38***	(−0.43 to −0.34)	−0.05*	(−0.09 to −0.01)	−0.09***	(−0.11 to −0.06)
Gender (male)	0.02	(−0.00 to 0.04)	0.01	(−0.01 to 0.03)	0.06***	(0.03 to 0.08)	0.04***	(0.02 to 0.06)
Charlson (0)	0.02	(−0.02 to 0.06)	0.03	(−0.00 to 0.05)	0.03	(−0.01 to 0.07)	0.01	(−0.01 to 0.04)
Charlson (2)	−0.03	(−0.06 to 0.01)	−0.02	(−0.05 to 0.01)	−0.04	(−0.08 to 0.01)	−0.05**	(−0.08 to −0.01)
Charlson (3–4)	−0.00	(−0.05 to 0.04)	−0.04*	(−0.07 to −0.00)	−0.05	(−0.09 to 0.00)	−0.05**	(−0.08 to −0.01)
Charlson (5+)	−0.12***	(−0.16 to −0.07)	−0.07***	(−0.11 to −0.03)	−0.11***	(−0.17 to −0.05)	−0.13***	(−0.17 to −0.09)
CHADS2 (0–1)	−0.00	(−0.04 to 0.04)	0.02	(−0.01 to 0.05)	0.02	(−0.02 to 0.06)	0.00	(−0.03 to 0.03)
CHADS2 (3–4)	−0.04*	(−0.08 to −0.00)	−0.01	(−0.03 to 0.02)	−0.01	(−0.05 to 0.03)	−0.03*	(−0.05 to −0.00)
CHADS2 (5+)	−0.02	(−0.08 to 0.04)	−0.04	(−0.10 to 0.02)	−0.04	(−0.10 to 0.03)	−0.04	(−0.09 to 0.01)
Rural	−0.00	(−0.07 to 0.06)	−0.04*	(−0.08 to −0.01)	−0.05	(−0.11 to 0.01)	−0.03	(−0.07 to 0.01)
Micropolitan	−0.01	(−0.06 to 0.04)	−0.03**	(−0.05 to −0.01)	0.00	(−0.05 to 0.05)	−0.01	(−0.04 to 0.02)
Postperiod	−0.02	(−0.05 to 0.01)	0.03**	(0.01 to 0.05)	0.01	(−0.02 to 0.04)	−0.01	(−0.03 to 0.01)
Treatment group	−0.38***	(−0.42 to −0.34)	−0.14***	(−0.18 to −0.10)	−0.44***	(−0.50 to −0.39)	−0.42***	(−0.46 to −0.38)
Post-treatment	0.09*	(0.02 to 0.16)	0.03	(−0.03 to 0.09)	0.17***	(0.09 to 0.25)	0.14***	(0.08 to 0.19)
Negative control	−0.44***	(−0.53 to −0.36)	−0.21***	(−0.27 to −0.15)	−0.49***	(−0.64 to −0.34)	−0.49***	(−0.57 to −0.40)
Post-negative control	−0.03	(−0.19 to 0.13)	−0.02	(−0.11 to 0.08)	0.09	(−0.10 to 0.29)	0.02	(−0.10 to 0.14)
0 prediagnosis visits	−0.05*	(−0.09 to −0.00)	−0.06***	(−0.10 to −0.03)	0.09**	(0.03 to 0.14)	0.02	(−0.01 to 0.06)
2+ prediagnosis visits	0.05***	(0.02 to 0.08)	0.04***	(0.02 to 0.07)	0.08***	(0.04 to 0.12)	0.06***	(0.03 to 0.08)
Primary stroke centre	−0.01	(−0.06 to 0.04)	−0.02	(−0.05 to 0.00)				
GWTG participation	−0.01	(−0.04 to 0.01)	−0.00	(−0.03 to 0.02)				
4–99 beds	−0.04*	(−0.09 to −0.00)	0.01	(−0.02 to 0.04)				
500+ beds	−0.03	(−0.07 to 0.01)	−0.01	(−0.05 to 0.03)				
25+ miles	−0.10***	(−0.15 to −0.05)	−0.04***	(−0.06 to −0.02)				
Rural provider	0.08	(−0.00 to 0.17)	0.05	(−0.01 to 0.10)	0.12**	(0.04 to 0.20)	0.11***	(0.05 to 0.17)
Micropolitan provider	0.05*	(0.00 to 0.09)	0.04*	(0.00 to 0.08)	0.01	(−0.04 to 0.06)	0.04*	(0.01 to 0.07)
Inpt Index Claim							−0.03**	(−0.05 to −0.01)
Observations	5235		5235		4694		9380	

95% CIs in parentheses.

*p<0.05.

**p<0.01.

***p<0.001.

CHADS2, C—congestive heart failure, H—hypertension, A—>75 years, D—diabetes mellitus, S—prior stroke or stroke symptoms; GWTG, Get With The Guidelines; Inpt, inpatient; OAT, oral anticoagulation therapy; RX, prescription.

intervention cohort, as well as the higher than expected OAT initiation in the negative control (perceived low risk) cohort, are interesting. This finding may reflect the nature of health insurance claims data, which may miss prescription claims (especially given the availability of low-cost mediations at retail stores). However, our measured rates of OAT initiation in the AF cohort are consistent with prior studies.⁴⁴ While we believe underutilisation of OAT among incident AF and paroxysmal AF patients is evident in our findings, this underutilisation should be reported with caution given the inherent limitations of using claims data. We view our results, not as an indictment suggesting poor quality of care for new onset AF, but rather as an examination of positive trends in guideline concordant care for patients with incident AF following policy change, and an absence of unintended negative effects on care. We also note that the rate of anticoagulation observed in the positive control may represent a realistic target rate for incident AF and patients with paroxysmal AF when using claims data.

The study has several strengths. First, the use of perceived very high-risk and perceived low-risk control groups allow for greater mitigation of potential time bias between the preperiod and postperiod that is common in observational studies. We are not aware of published OAT initiation rates for individuals with mechanical heart valves or significant thromboembolism. Using this group as a benchmark sheds new light on previous observational studies. Second, using a statewide claims database with approximately one million privately insured state workers, spouses, dependents and retirees increases the generalisability of our findings. Third, linking with the Area Resource File and OSCAR databases provides a rich array of county and hospital facility control variables, respectively. Fourth, we included multiple controls for comorbid conditions and relative contraindications to OAT. Finally, the clustering of individuals within the hospital in which they received treatment mitigates potential effects of outlier hospitals on the population-averaged effect of the policy change.⁴⁰

There are several limitations of our study. First, we used a quasi-experimental observational study design. Without randomisation, we cannot eliminate threats to internal validity such as regression to the mean, history and instrumentation. For example, unmeasured differences in all cohorts between preperiod and postperiod may have confounded our findings. Second, because we used claims data, we may have misclassified OAT initiation, especially with the popularity of low-cost generic OAT that could be purchased without billing the insurer.⁴³ We have no reason to suspect differential bias in pharmacy claims for warfarin across the three cohorts regarding OAT initiation. Furthermore, if present, this trend may increase with time, which would bias OAT initiation downwards in the postperiod; this may help explain the slight decrease in OAT initiation among the

guideline-positive cohort. Importantly, our sensitivity analyses suggested that findings were robust to alternative definitions of OAT initiation. Third, we could not control for individual level race, ethnicity or socioeconomic status. However, we controlled for county level indicators of race and socioeconomic status to mitigate these potential effects. Fourth, most members of our cohorts had employee-sponsored group health insurance; results may not generalise to publicly insured populations. Notably, our cohorts included a large proportion of retired Medicare enrollees utilising both their Medicare and NCSHP benefits, which serves to enhance generalisability to Medicare beneficiaries. Finally, new medications for OAT were approved for reduction of stroke risk in patients with AF in late 2010. We purposely limited our study window to exclude these medications which, while more expensive than warfarin, do not require the same frequency of laboratory monitoring and titration of dosage.

CONCLUSION

Our findings show that following NPSGs concerning anticoagulation, lower rates of anticoagulation among incident eligible patients with AF were not observed. Rather when compared with control groups which declined in the rate of anticoagulation, rates of anticoagulation increased among eligible patients with incident AF. OAT initiation should be re-examined with additional years of data, broader geographic representation and the inclusion of novel anticoagulation agents to support or refute our findings. Our work demonstrates the direct (in primary analysis of patients with incident inpatient diagnosed AF) and indirect (in sensitivity analysis of patients with incident outpatient diagnosed AF) changes in anticoagulation practice co-occurring with changes in policies of healthcare regulatory agencies via patient safety and quality improvement initiatives.

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