Accuracy and validation of an automated electronic algorithm to identify patients with atrial fibrillation at risk for stroke

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Background There is no universally accepted algorithm for identifying atrial fibrillation (AF) patients and stroke risk using electronic data for use in performance measures.

Methods Patients with AF seen in clinic were identified based on *International Classification of Diseases, Ninth Revision (ICD-9)* codes. $CHADS_2$ and CHA_2DS_s-Vasc scores were derived from a broad, 10-year algorithm using *IICD-9* codes dating back 10 years and a restrictive, 1-year algorithm that required a diagnosis within the past year. Accuracy of claims-based AF diagnoses and of each stroke risk classification algorithm were evaluated using chart reviews for 300 patients. These algorithms were applied to assess system-wide anticoagulation rates.

Results Between 6/1/2011, and 5/31/2012, we identified 6,397 patients with AF. Chart reviews confirmed AF or atrial flutter in 95.7%. A 1-year algorithm using CHA_2DS_2-Vasc score ≥2 to identify patients at risk for stroke maximized positive predictive value (97.5% [negative predictive value 65.1%]). The PPV of the 10-year algorithm using $CHADS_2$ was 88.0%; 12% those identified as high-risk had $CHADS_2$ scores <2. Anticoagulation rates were identical using 1-year and 10-year algorithms for patients with $CHADS_2$ scores ≥2 (58.5% on anticoagulation) and CHA_2DS_2-Vasc scores ≥2 (56.0% on anticoagulation).

Conclusions Automated methods can be used to identify patients with prevalent AF indicated for anticoagulation but may have misclassification up to 12%, which limits the utility of relying on administrative data alone for quality assessment. Misclassification is minimized by requiring comorbidity diagnoses within the prior year and using a CHA_2DS2-Vasc based algorithm. Despite differences in accuracy between algorithms, system-wide anticoagulation rates assessed were similar regardless of algorithm used. (Am Heart J 2015;169:39-44.e2.)

Stroke is a leading cause of morbidity and mortality in patients with atrial fibrillation (AF). Anticoagulation with vitamin K antagonists or novel oral anticoagulants effectively reduces risk of stroke in those with moderate to high risk for stroke. Multiple studies, however, have shown that anticoagulation rates among eligible AF patients are suboptimal.[1,2] The American College of Cardiology and American Heart Association, in collaboration with the Physician Consortium for Performance Improvement, have developed performance measures aimed to assess rates of anticoagulation for eligible AF patients.[3]

Currently, the Centers for Medicare and Medicaid Services Physician Quality Reporting Initiative reimburses providers and health systems for reporting on quality measures. Similarly, the Physician Group Practice Demonstration project rewards physician groups for reporting on quality measures for diabetes, congestive heart failure, coronary artery disease, and prevention care, including warfarin therapy for patients with heart failure and AF. The recently passed Affordable Care Act includes a number of provisions to expand both "pay for reporting" and "pay for performance" initiatives with the goal to improve quality of care for a number of chronic conditions, including ischemic vascular disease, heart failure, and coronary artery disease.[4,5] Yet, there are practical challenges in collecting these data in routine clinical practice. Although manual chart review remains the criterion standard, there is increasing interest in using administrative claims or electronic medical records data to monitor and report hospital and physician performance. To date, there is no universally

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accepted algorithm for how to best use administrative codes to screen for AF and evaluate stroke risk.

The goal of this study is to create and validate an algorithm for identifying patients with AF as well as to identify those at moderate to high risk of stroke using administrative data. We specifically addressed several important methodological questions including: (1) How many more AF cases will be found if one uses a broad (10-years) versus narrower (1-year) time horizon? (2) What proportion of patients with administrative codes for AF truly has AF based on chart review? (3) How well can one derive $CHADS_2$ or CHA_2DS_2-Vasc scores from claims data? (4) What is the sensitivity, specificity, and positive and negative predictive value (NPV) of a claims-based AF stroke risk score algorithm? And (5) How does variation in the algorithm for identifying AF patients at risk for stroke impact actual assessment of rates of anticoagulation?

Methods

Identifying patients with prevalent AF

An algorithm was developed to identify patients with prevalent AF using diagnosis codes available electronically from inpatient, outpatient, and emergency department visits in the Duke University Health System. Patients were eligible for selection if they had ≥2 outpatient visits with a cardiologist or primary care provider in the specified study window: between 6/1/2011, and 5/31/2012. Patients with AF were identified by screening for an *International Classification of Diseases, Ninth Revision* (*ICD-9*) code of 427.31 (AF) or 427.32 (atrial flutter) coded for 1 inpatient or 2 outpatient or emergency department visits between 5/31/2001, and 11/31/2011, which corresponds to the period 10 years before and through the first 6 months of the study window.[6] To identify prevalent AF, ≥1 of the diagnosis codes must have been within the year before or within the first 6 months of the start of the study period (5/31/2010 to 11/31/2011). Patients with *ICD-9* codes for atrial flutter only were excluded.

Age and sex were available as a demographic variable in the electronic health record. Comorbidity data were evaluated using *ICD-9* diagnosis codes. Comorbidities were defined as any 1 inpatient or 2 outpatient or emergency visits with an *ICD-9* code of interest between 6/1/2001 to 11/31/2011. This time window allowed for identification of comorbidities that were diagnosed within 10 years before or within the first 6 months of the study window. *International Classification of Diseases, Ninth Revision* codes used for congestive heart failure (398.91, 402.01, 402.11, 402.91, 404.03, 404.11, 404.13, 404.91, 404.93, and 428.x), diabetes (250.x, 357.2, 362.0, and 366.41), hypertension (401.x, 402.x, 403.x, 404.x, and 405.x), stroke or transient ischemic attack (433.01, 433.11, 433.21, 433.31, 433.91, 434.x, 435.x, and v12.54), and vascular disease (coronary artery disease 433.x, 410.x, 411.x, 412.x, 413.x, and 414.x; other cerebrovascular disease 436.x, 437.x, 438.x, and 433.x; and atherosclerotic vascular disease 440.x, 447.1, 557.1, and 557.9) were based on those evaluated by Rothendler et al.[7]

In addition, we also evaluated a more restrictive definition of comorbidities, which required the most recent diagnosis of the comorbidity to have occurred in the past year (after 5/31/2010). $CHADS_2$ and CHA_2DS_2-Vasc scores were calculated using a broader "10-year" (comorbidity codes used for the past 10 years) assessment and a more restrictive "1-year" (comorbidity codes used for the past 10 years with ≥1 code within the past year) assessment of comorbidities. Patients with $CHADS_2$ and CHA_2DS_2-Vasc scores of ≥2 were considered to have a potential indication for anticoagulation based on the demonstrated high risk of stroke.[8,9]

Manual chart review validation

Chart reviews were performed to validate the accuracy of the electronically derived $CHADS_2$ and CHA_2DS_2-Vasc scores. Chart reviews were performed for 300 randomly selected patients, stratified by $CHADS_2$ scores generated using the 10-year comorbidity code definitions (eg, at any time in the past 10 years): 100 with $CHADS_2$ score <2, 100 with $CHADS_2$ score = 2, and 100 with $CHADS_2$ score >2. Each patient's chart was reviewed by 1 of 3 reviewers (J.A.R., W.S., and L.R.), who were instructed to evaluate all outpatient, inpatient, and clinic notes as well as electrocardiograms (ECGs) for documentation of a clinical diagnosis of AF. Chart reviewers were blinded to the electronic comorbidity assessments. All notes dating back to 6/1/2006 were reviewed for presence of comorbidities. Comorbidities identified in chart reviews were used to generate the patient's $CHADS_2$ and CHA_2DS_2-Vasc scores based on clinical notes as the "criterion standard." Data from chart reviews were applied to the entire population of patients identified with AF, and the following parameters were calculated: sensitivity, specificity, positive predictive value (PPV), and NPVs for 4 electronic algorithms including $CHADS_2$ score ≥2 generated from 10-year and 1-year comorbidity definitions and CHA_2DS_2-Vasc score ≥2 generated from 10-year and 1-year comorbidity definitions.

Assessment of anticoagulation rates

Medication data, reconciled at each clinic visit, were available electronically through the health system electronic medical record. The most recent electronic medication list from the study period (6/1/2011, and 5/31/2012) was evaluated to determine a patient's anticoagulation status. Anticoagulation status was determined by the presence of an active prescription for any of the following medications: warfarin, enoxaparin, dabigatran, apixaban, rivaroxban, or heparin on the patient medication list. Rates of anticoagulation by $CHADS_2$ and CHA_2DS_2-Vasc scores, using both the 10-year and 1-year definitions of each, were evaluated.

Statistical analysis

Descriptive statistics summarizing the population characteristics are presented. Data analyses were performed