Published in final edited form as:

Am J Cardiol. 2014 May 15; 113(10): 1668–1673. doi:10.1016/j.amjcard.2014.02.023.

Usefulness of a Low CHADS2 or CHA2DS2-VASc Score to Predict Normal Diagnostic Testing in Emergency Department Patients With an Acute Exacerbation of Previously Diagnosed Atrial Fibrillation

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Abstract

International guidelines do not specify what testing should be performed during emergency department (ED) evaluations for patients presenting with an exacerbation of previously diagnosed atrial fibrillation (AF). We hypothesized that low CHADS2 and CHA2DS2-VASc scores predict normal routine diagnostic testing in these patients. We conducted an analysis within a prospective observational cohort study at a university-affiliated hospital. We included patients with previously diagnosed AF and who presented to the ED primarily for an AF-related complaint. Logistic regression was used to analyze the association between CHADS2 and CHA2DS2-VASc scores and abnormal results for blood counts, electrolytes, cardiac markers, thyroid function, and chest x-rays. We included 216 patients in this analysis. The odds ratios (95% confidence interval) for each point increase in CHADS2 for abnormal blood counts, electrolytes, troponin I, brain natriuretic peptide, thyroid function, and chest x-ray were 1.28 (0.99 to 1.65), 1.48 (1.19 to 1.84), 1.42 (1.10 to 1.82), 1.66 (1.15 to 2.41), 0.95 (0.70 to 1.29), and 1.17 (0.94 to 1.44), respectively. The corresponding odds ratios (95% confidence interval) for each point increase in CHA2DS2-VASc were 1.17 (0.96 to 1.42), 1.27 (1.09 to 1.49), 1.30 (1.07 to 1.57), 1.57 (1.18 to 2.10), 0.98 (0.79 to 1.22), and 1.14 (0.97 to 1.33), respectively. Among ED patients with established AF who underwent evaluation for acutely symptomatic AF, nearly 3/4 of routine diagnostic tests return to normal. In conclusion, patients with CHADS2 or CHA2DS2-VASc score of 0 have the lowest likelihood of abnormal studies and may represent an easily identifiable group of patients who need fewer ED tests.

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This trial is registered at www.clinicaltrials.gov (NCT01138644).

Disclosures

Barrett: Consultant for Red Bull GmbH (Fuschl am See, Austria), Editorial Board, *Annals of Emergency Medicine*. There are no conflicts of interest in connection with this submission or are there any copyright constraints.

Supplementary Data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.amjcard.2014.02.023>.

Atrial fibrillation (AF) affects 3 to 6 million patients in the United States with annual healthcare costs of \$6 to \$26 billion.^{1,2} Emergency department (ED) services trail only inpatient services and office visits as the principal driver of medical costs.² A common course for patients with established AF is that the disease becomes a chronic condition with frequent exacerbations leading to ED evaluations and hospitalizations during which the same diagnostic studies are frequently repeated.^{3,4} International guidelines for managing AF do not provide specific recommendations for ED management and diagnostic testing.^{3,5-7} The guidelines do state that frequent assessment of a patient's risk for thromboembolism, using the CHADS2 (Congestive heart failure (1 point), Hypertension (1 point), Age 75y (1 point), Diabetes (1 point), prior Stroke/transient ischemic attack (2 points)) and CHA2DS2-VASc (Congestive heart failure (1 point), Hypertension (1 point), Age 75y (2 points), Diabetes (1 point), prior Stroke/transient ischemic attack (2 points)-Vascular disease [prior myocardial infarction, peripheral artery disease, or aortic plaque] (1 point), Age 65-74y (1 point), Sex category [i.e., female gender] (1 point)) scores,⁸⁻¹¹ is a main objective in AF management.^{3,5-7,11} Studies have shown that the CHADS2 and CHA2DS2-VASc scores are predictive of a wide array of important clinical outcomes in patients with and without AF.¹²⁻¹⁵ The CHADS2 and CHA2DS2-VASc scores may be sufficient measures of increased overall risk¹⁶ to identify patients who may be safely managed with limited testing. We investigated the frequency of diagnostic testing and the prevalence of abnormal results in a prospective cohort of patients with a previous history of AF who presented to the ED with primary AF-related complaints. We also evaluated the performance of the CHADS2 and CHA2DS2-VASc scores to predict which patients have abnormal results to common diagnostics tests.

Methods

We conducted a prospective observational cohort study (NCT01138644) at a single, tertiary care, university-affiliated hospital adult ED that treats 65,000 adult patients annually. This study is a secondary investigation of the Atrial Fibrillation/Flutter Outcome Risk Determination study, the details of which have been previously reported.¹⁷ Briefly, the research team identified patients presenting with signs (e.g., tachycardia, dyspnea) and symptoms (e.g., palpitations, chest pain, shortness of breath, weakness, lightheadedness, presyncope, or syncope) consistent with symptomatic AF or atrial flutter. We enrolled the first subject on June 8, 2010 and completed enrollment on February 28, 2013. The diagnosis of AF was confirmed by an independent cardiologist's review of the electrocardiogram performed on the day of the patient's ED evaluation. We classified each patient's AF type as newly diagnosed or an established diagnosis (which included paroxysmal, persistent, or permanent AF) based on the American College of Cardiology/American Heart Association Task Force on Practice Guidelines.³ The decision to perform diagnostic testing in the ED was at the discretion of the treating clinician.

We focused our analysis on patients with an established diagnosis of AF as these patients previously underwent the recommended battery of testing aimed to exclude an underlying cause (e.g., structural heart disease, thyroid disease) of their AF. Patients with newly diagnosed AF, however, may have little previous diagnostic testing data available and the treating clinician may want additional laboratory and x-ray information before making

disposition and treatment decisions. We included only patients whose ED evaluations were primarily for AF. To determine whether the ED evaluation was primarily for an AF, a board-certified emergency medicine physician investigator reviewed the ED records of all patients who consented for the study. The principal investigator used a standardized protocol to determine whether uncontrolled AF was the primary reason for the ED visit. A board-certified electrophysiologist investigator provided a second review of a randomly selected 31% subset of the enrollments. We measured the absolute agreement and Cohen's kappa statistic between the 2 reviewers' designation for the primary cause of ED visits.¹⁸ We calculated 95% confidence intervals (CIs) for the kappa using 1,000 bootstrap resamples.¹⁹

We collected data on all diagnostic testing performed in the ED during each subject's evaluation, including electrocardiograms, laboratory investigations, and x-ray studies. We focused this investigation on the following commonly ordered ED diagnostic studies: complete blood counts (CBCs), basic metabolic panel, troponin I, brain natriuretic peptide (BNP), thyroid function tests, and the chest x-ray. We made an a priori determination that the following diagnostic tests should be considered standard clinical practice and did not include them in the analysis: bedside glucose testing in patients with known diabetes, creatinine in patients with chronic kidney disease and BNP testing in patients with established heart failure. We used normal range references published on the National Library of Medicine's Medline Plus and National Endocrine and Metabolic Diseases Information Service websites to categorize each patient's laboratory investigations as within the normal or abnormal range (i.e., outside the normal range of values).^{20,21} A detailed description of what constituted a normal and abnormal test is listed in the Appendix Table 1.

We calculated CHADS₂ and CHA₂DS₂-VASc scores^{8–10} for each patient using medical history data obtained through both patient interview and medical record review at the time of the ED evaluation. We investigated both the CHADS₂ and CHA₂DS₂-VASc scores. The CHADS₂ score remains the preferred predictor for thromboembolic risk in the United States.^{22,23} The most recent 2012 European Society of Cardiology guidelines recommended that the CHA₂DS₂-VASc score replace the CHADS₂ as studies have shown it to be superior in identifying truly low-risk patients.¹¹

This investigation's primary outcome variable was the proportion of patients with abnormal results for these routine diagnostic tests: CBC, basic metabolic panel, troponin I, BNP, thyroid function tests, and chest x-ray. CHADS₂ and CHA₂DS₂-VASc scores were the primary exposure variables. CHADS₂ score categories included scores of 0, 1, 2, 3, and 4 to 6. Scores 4 to 6 were shrunk into one category because of small sample sizes with these high scores and similar clinical significance of scores 4.^{8–11} Similarly, CHA₂DS₂-VASc score categories included scores of 0, 1, 2, 3, 4, 5, and 6 to 9. We calculated the proportion of patients in each CHADS₂ and CHA₂DS₂-VASc category with abnormal results for each of the routine diagnostic test. We constructed a series of simple logistic regression models. In each model, either CHADS₂ or CHA₂DS₂-VASc score category was the independent variable. Dependent variables included dichotomized (normal or abnormal) diagnostic test results for CBC, basic metabolic panel, troponin I, BNP, thyroid function tests, and chest x-ray, with each test considered in a separate model. Therefore, 12 separate simple logistic regression models were constructed with 6 having CHADS₂ as the independent variable and

6 having CHA2DS2-VASc as the independent variable. Model output included the odds ratio with 95% CI for the association between CHADS2 or CHA2DS2-VASc score category and an abnormal diagnostic test.

In secondary analyses, we also dichotomized CHADS2 and CHA2DS2-VASc scores as 0 or

1. This dichotomization was based on previous literature that classified patients with CHADS2 and CHA2DS2-VASc scores of 0 as lowest risk for thromboembolism.^{3,9–11,23}

We then calculated the proportion of patients with these dichotomized CHADS2 and CHA2DS2-VASc categories with abnormal diagnostic tests. CIs for these proportions were calculated by Wilson's method for calculating binomial proportion interval estimates.²⁴

Statistical analyses were performed with Stata 12 (College Station, Texas) and IBM SPSS Version 21 (Armonk, New York). Our medical center's institutional review board approved this study and patients provided written informed consent.

Results

Between June 2010 and February 2013, we prospectively enrolled 519 patients in the Atrial Fibrillation/Flutter Outcome Risk Determination study including 334 patients whose ED visits were for primary AF. Of them, 216 (64.7%) patients having AF as both a previously established diagnosis and the primary reason for ED presentation constituted the study cohort for this analysis. The principal investigator adjudicated whether AF was the primary indication for the ED visit in all patients. An electrophysiologist independently reviewed 163 (31.4%) of the records. Of those 163 records, concordance was found in 139, corresponding to a kappa of 0.79 (95% CI 0.70 to 0.88).

Table 1 lists the baseline characteristics for the 216 patients included in this study. Table 2 lists the frequency of diagnostic studies performed in the ED and the percentages of abnormal results. The odds ratios for CHADS2 and CHA2DS2-VASc scores predicting an abnormal result for each routine diagnostic study are listed in Table 3. Figures 1 and 2 show the proportion of patients who had abnormal diagnostic tests in the ED stratified by CHADS2 and CHA2DS2-VASc scores. Table 4 lists that for those with CHADS2 or CHA2DS2-VASc score of 0, CBC, basic metabolic panel, and BNP each were abnormal in <10% of patients. Additional details on the patient's baseline characteristics and ED evaluations are listed in the Appendix Tables 2 and 3.

Discussion

Our investigation suggests that most patients with established AF will not have a specific inciting etiology causing an exacerbation of symptoms detected on routine laboratory or x-ray studies. Among ED patients with established AF who underwent evaluation for an exacerbation of AF, >75% of routine diagnostic tests return with normal results. Furthermore, patients with a low CHADS2 or CHA2DS2-VASc score are the least likely patients to have abnormalities detected on routine testing. Specifically, >90% of patients with a CHADS2 score of 0 had all normal results for CBC, chemistry, and troponin testing, the 3 most common diagnostic tests obtained by clinicians for patients included in our cohort.

The decision to order diagnostic tests in the ED is typically determined by the ED clinician, and there are no formal guidelines that recommend a standardized approach for managing patients with established AF in the ED.^{6,25} A common course of AF is that patients frequently have recurrent exacerbations without a specific inciting factor.^{3,4} However, without any standardized clinical protocols, many ED clinicians search for a specific etiology of the recurrent AF such as hypokalemia, anemia, cardiac ischemia, or decompensated heart failure.^{26,27} Furthermore, as the majority of ED patients in the United States are treated with rate control agents regardless of the testing results,^{28,29} routine testing may have little impact on patient management while hindering ED throughput. Results of this study suggest that routine diagnostic testing for patients with AF in the ED could potentially be reduced with standardized guidelines outlining which patients are most likely to benefit from the laboratory and x-ray evaluations.

We investigated whether the CHADS2 and CHA2DS2-VASc scores could aid clinicians in understanding which of the ED patients with established AF have lower odds of abnormal testing. The CHADS2 and CHA2DS2-VASc scores include variables such as age, heart failure, and diabetes that have previously been associated with increased risk of hospitalization, 30-day adverse events, and death in ED patients with AF.^{27,28} Patients with CHADS2 and CHA2DS2-VASc scores of 0 have the lowest proportions of abnormal studies and may represent an easily identifiable group of patients who can be managed without routine ED testing. Such an easily calculated scoring system, which experts in the field advise should be regularly checked on all patients with AF,¹¹ might provide an objective tool for decreasing the number of unnecessary routine studies in patients whose presenting signs and symptoms do not otherwise require evaluation. Additional evaluation of using these scores to assist with clinical decision-making about when to order diagnostic tests is needed before such a strategy could be implemented clinically.

Our study has several limitations. We investigated an alternative outcome, predicting normal routine testing, for which the CHADS2 and CHA2DS2-VASc scores were not derived to predict. However, the CHADS2 and CHA2DS2-VASc scores are predictive of a wide array of important clinical outcomes.^{12–15} These scores include predictors that have been independently associated with 30-day adverse events in patients with AF.^{27,28} We included patients whose ED evaluations were judged to be for primary AF. Patients whose AF was incidental or a secondary complaint represent a different group as the ED clinician's decision to order diagnostic studies would likely be focused on the patient's primary complaint rather than solely evaluating their AF. We acknowledge that normal test results are often very important in managing patients with cardiovascular disease. However, physicians often search for an acute insult (e.g., acute coronary syndrome, electrolyte abnormality, and thyroid dysfunction) as the cause of an AF exacerbation despite such precipitants rarely being identified in patients without other concerning symptoms.^{26,30} This study was conducted at a single university-affiliated referral center with resident physicians, fellows, and faculty physicians staffing the ED. There is the potential that resident physicians are more conservative in managing patients with AF than community clinicians and order additional ED diagnostic studies. There is also the potential that our ED population of patients with AF has more complicated medical co-morbidities, thus, requiring more extensive ED evaluation. However, the CHADS2 and CHA2DS2-VASc scores

provide an objective measure of the cohort's overall disease severity, and our patients' distribution of score approximates previous large investigations.^{9,10} Acknowledging these limitations, we believe that our results provide evidence that an opportunity exists to improve resource utilization by reducing the frequency of laboratory and x-ray testing.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

No industry financial support or compensation has been or will be received for conducting this study. Dr. Barrett and this study are funded by the NIH grant K23 HL102069 from the National Heart, Lung and Blood Institute, Bethesda, Maryland. Dr. Self received funding from the National Center for Advancing Translational Sciences, Bethesda, Maryland (KL2 TR000446). This study was also funded in part through UL1 TR000445 from the National Center for Advancing Translational Sciences/NIH, Bethesda, Maryland.

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Figure 1.

Percentage (*circles*) and 95% CI (*brackets*) of patients with abnormal test results by CHADS2 score. The overall number of patients who underwent each of the 6 diagnostic tests (CBC, chemistries, troponin I, BNP, thyroid function tests, and chest x-ray) is denoted in each subfigure title. The number and percentage of patients with each CHADS2 score who underwent the diagnostic test are shown below each x-axis.

Figure 2.

Percentage (*circles*) and 95% CI (*brackets*) of patients with abnormal test results by CHA2DS2-VASc score. The overall number of patients who underwent each of the 6 diagnostic tests (CBC, chemistries, troponin I, BNP, thyroid function tests, and chest x-ray) is denoted in each subfigure title. The number and percentage of patients with each CHA2DS2-VASc score who underwent the diagnostic test are shown below each x-axis.

Table 1

Baseline patient characteristics

Variable	Study Population (n = 216)
Age (yrs)	65.5 (57, 75)
Women	84 (39)
White	192 (89)
Black	22 (10)
Chief complaint in triage	
Palpitations	89 (41)
Chest pain	35 (16)
Dyspnea	25 (12)
Tachycardia	28 (13)
Syncope	7 (3)
Blood pressure, systolic (mm Hg)	132 (117, 147)
Blood pressure, diastolic (mm Hg)	82 (72, 91)
Heart rate (beats/min)	120 (95, 137)
Duration of symptoms before ED presentation	
<48 hours	147 (50)
>48 hours	49 (23)
Unknown	20 (9)
CHADS2 score	2 (1, 3)
CHA2DS2-VASc score	3 (1, 4)
Type of atrial fibrillation	
Paroxysmal	153 (71)
Persistent	38 (18)
Permanent	25 (11)
Medical history	
Heart failure	62 (29)
Myocardial infarction	45 (21)
Coronary artery disease	68 (32)
Hypertension	148 (69)
Diabetes mellitus	48 (22)
Peripheral vascular disease	18 (8)
Cerebrovascular accident	26 (12)
Transient ischemic attack	17 (8)

Data are presented as n (%) and median (IQR).

IQR = interquartile range.

Table 2

Frequency of abnormal results among the diagnostic studies performed in the emergency department (ED)

Variable	Patients With Test Completed (n = 216)	Patients With Abnormal Result Among Patients With Test Completed (n = 216)
CBC	208 (96)	32 (15)
Basic metabolic panel	216 (100)	68 (31)
Troponin I	216 (100)	33 (15)
BNP	146 (68)	22 (15)
Thyroid function tests	121 (56)	33 (27)
Chest x-ray	180 (83)	68 (38)

Data are presented as n (%).

BNP = brain natriuretic peptide; CBC = complete blood count.

Table 3

Odds ratios (ORs; 95% confidence interval [CI]) for CHADS2 and CHA2DS2-VASc scores to predict abnormal diagnostic testing

Variable	Abnormal CBC (n = 208)	Abnormal Basic Metabolic Panel (n = 216)	Abnormal Troponin I (n = 216)	Abnormal BNP* (n = 146)	Abnormal Thyroid Function Testing (n = 120)	Abnormal Chest X-Ray (n = 179)
CHADS2	1.28 (0.99–1.65)	1.48 (1.19–1.84)	1.42 (1.10–1.82)	1.66 (1.15–2.41)	0.95 (0.70–1.29)	1.17 (0.94–1.44)
CHA2DS2-VASc	1.17 (0.96–1.42)	1.27 (1.09–1.49)	1.30 (1.07–1.57)	1.57 (1.18–2.10)	0.98 (0.79–1.22)	1.14 (0.97–1.33)

ORs indicated increased odds of having an abnormal test result associated with each incremental score increase of 1 in the CHADS2 or CHA2DS2-VASc score.

BNP = brain natriuretic peptide; CBC = complete blood count.

* Patients with known history of heart failure excluded because of likelihood of chronically elevated BNP levels.

Table 4

Percentages of abnormal diagnostic testing among emergency department (ED) patients stratified by CHADS2 scores of 0 (n = 40) versus 1 (n = 176) and CHA2DS2-VASc scores of 0 (n = 19) versus 1 (n = 197)

Variable	CHADS2 Score = 0	CHADS2 Score = 1	CHA2DS2-VASc Score = 0	CHA2DS2-VASc Score = 1
Abnormal CBC (n = 208; %)	2.8	18	6.3	16.1
Abnormal basic metabolic panel (n = 216; %)	7.5	36.9	0	34.5
Abnormal troponin I (n = 216; %)	10	16.5	15.8	15.2
Abnormal BNP (n = 146; %)	2.6	19.6	0	17.3
Abnormal thyroid function test (n = 121; %)	20.8	28.9	12.5	28.3
Abnormal chest x-ray (n = 180; %)	18.8	41.9	7.1	40.4

BNP = brain natriuretic peptide; CBC = complete blood count.