CME Information: Implementation of a Novel Algorithm to Decrease Unnecessary Hospitalizations in Patients Presenting to a Community Emergency Department With Atrial Fibrillation

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CME

Implementation of a Novel Algorithm to Decrease Unnecessary Hospitalizations in Patients Presenting to a Community Emergency Department With Atrial Fibrillation

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ABSTRACT

Objectives: Atrial fibrillation (AFib) is the most common dysrhythmia in the United States. Patients seen in the emergency department (ED) in rapid AFib are often started on intravenous rate-controlling agents and admitted for several days. Although underlying and triggering illnesses must be addressed, AFib, intrinsically, is rarely life-threatening and can often be safely managed in an outpatient setting. At our academic community hospital, we implemented an algorithm to decrease hospital admissions for individuals presenting with a primary diagnosis of AFib. We focused on lenient oral rate control and discharge home. Our study evaluates outcomes after implementation of this algorithm.

Methods: Study design is a retrospective cohort analysis pre- and postimplementation of the algorithm. The primary outcome was hospital admissions. Secondary outcomes were 3- and 30-day ED visits and any associated hospital admissions. These outcomes were compared before (March 2013–February 2014) and after (March 2015–February 2016) implementation. Chi-square tests and logistic regressions were run to test for significant changes in the three outcome variables.

Results: A total of 1,108 individuals met inclusion criteria with 586 patients in the preimplementation group and 522 in the postimplementation group. Cohorts were broadly comparable in terms of demographics and health histories. Admissions for persons presenting with AFib after implementation decreased significantly (80.4% pre vs. 67.4% post, adjusted odds ratio [OR] = 3.4, $p < 0.001$). Despite this difference there was no change in ED return rates within 3 or 30 days (adjusted ORs = 0.93 and 0.89, $p = 0.91$ and 0.73, respectively).

Conclusions: Implementation of a novel algorithm to identify and treat low-risk patients with AFib can significantly decrease the rate of hospital admissions without increased ED returns. This simple algorithm could be adopted by other community hospitals and help lower costs.

Atrial fibrillation (AFib) affects three million people in the United States each year, and roughly one in four persons will develop AFib or atrial flutter (AFL) during their lifetime.[1] Once presenting to the emergency department (ED), most patients with rapid AFib/AFL are admitted to the hospital, accounting for the majority of healthcare expenditure associated with this condition.[2–5] Hospitalizations for AFib have

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increased by 66% over the past 20 years and account for 1% of ED visits.[2–5]

Despite the prevalence of this arrhythmia, there is substantial variation in the management of these patients while in the ED.[4,6–8] There are different practice patterns within the United States and also in other countries. No clear consensus guidelines exist to identify patients who require admission versus those who may be treated on an outpatient basis. Even the most recent guidelines from the American Heart Association (AHA) and American College of Cardiology (ACC) fail to describe ideal candidates for safe discharge home.[9] Often patients are treated with intravenous (IV) medications, undergo advanced imaging, receive urgent cardiology consultation, and are admitted to the hospital when, in reality, the dysrhythmia itself is rarely an immediately life-threatening condition. The majority of morbidity associated with AFib results from risk of future stroke, which is estimated to be as high as 12% in high-risk groups.[10]

The objective of this study was to examine whether implementation of an ED algorithm for patients with AFib/AFL could decrease hospital admission rates measured over a 1-year period. Our secondary outcomes were rates of ED return visits within 3 and 30 days for patients who were discharged from the index ED encounter.

METHODS

This is a retrospective observational study of patients presenting to an academic community hospital with a principal diagnosis of AFib/AFL over a 1-year period following initiation of our AFib algorithm from March 2015 to February 2016. Because some providers began using the algorithm several months prior to its official initiation, we elected to compare the study outcomes to those of a similar patient cohort from March 2013 to February 2014. The study was approved by our institution's research committee and institutional review board. The study was conducted under an approved waiver of consent.

Study Setting and Population

Our site is a 537-bed academic community hospital with an average annual ED census of 80,000 visits and is staffed by 43 emergency medicine (EM)-boarded attending physicians and 22 advanced practice providers. Certain areas of the ED also incorporate rotating EM residents from a nearby academic medical center. Approximately 30% of ED patients are covered by Medicare and 23% by Medicaid. The cardiology division has 35 board-certified cardiologists with 12 advanced practice providers all within the same hospital-owned integrated practice.

Our study population consisted of individuals presenting to the ED with a primary diagnosis of new or recurrent rapid AFib or AFL. The study cohorts encompassed all acuities, as well as patients already on anticoagulation. Individuals with alternate primary diagnoses, e.g., sepsis, were excluded, as were patients who had a secondary diagnosis of AFib and those who were under 18 years of age, pregnant, or incarcerated.

Protocol

The AFib algorithm was the result of collaboration between our emergency and cardiology departments (Figure 1). A group of electrophysiologists, general cardiologists, emergency physicians, and quality nurse leaders participated in a collaborative that focused on our approach to treating AFib/AFL patients presenting to the ED. An algorithm was created that outlined evaluation, diagnosis, treatment, and follow-up. The design was intentionally simple and straightforward so that emergency providers would not be overburdened with a complicated process in the chaotic environment of the ED.

The algorithm outlined the care of patients presenting to the ED with rapid AFib/AFL. (A rapid heart rate was defined as a rate greater than 100 beats/min.) It was critical to first consider the presence of a serious underlying diagnosis, e.g., pulmonary embolism, for which the algorithm was not intended. Once this was done, the algorithm outlined four high-risk features requiring admission: hemodynamic instability, acute heart failure, acute coronary syndrome (ACS), and syncope. Hospitalization of patients with high-risk features or underlying etiologies allowed for monitoring of patients while initiating therapies, obtaining imaging, and cardiology consultation. Hemodynamic instability was defined by relative or absolute hypotension. Acute heart failure was defined by ED admission diagnosis. ACS was determined based on an admission diagnosis of ST-elevation myocardial infarction or non-ST-elevation myocardial infarction or ACS and not only a finding of elevated troponin. Similarly, syncope was based on admission diagnosis.

All patients undergoing evaluation in the ED typically received electrolyte panel, thyroid studies, and

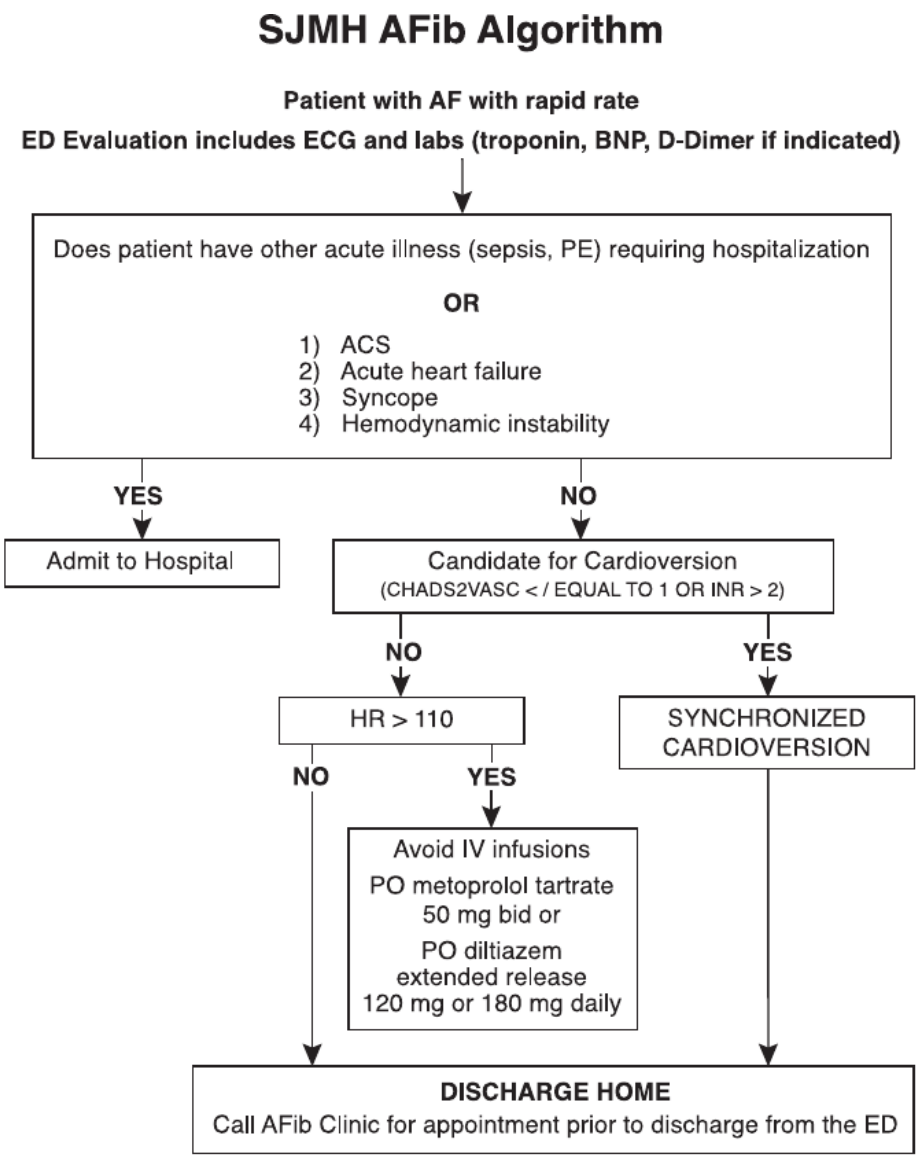

Figure 1. AFib algorithm. ACS = acute coronary syndrome; AFib = atrial fibrillation; BNP = brain natriuretic peptide; HR = heart rate; INR = international normalized ratio; PE = pulmonary embolism; SJMH = St. Joseph Mercy Hospital.

chest x-ray. Troponin testing was recommended only with concern for ACS as elevations are a common finding in patients with AFib with rapid rate. BNP testing was limited to situations where the clinician held concern for acute heart failure.

Patients without high-risk features were considered candidates for discharge home. Our primary focus for the analysis was on lower-acuity patients who were identified as having a score of 3, 4, or 5 on an institutional 30-day mortality prediction score (Pmort30).[11,12] All patients presenting to our ED are assigned scores between 1 and 5 based on vital signs, comorbidities, and presence of certain clinical features. Pmort scores are electronically calculated through a computer application that incorporates data from the electronic medical record and ED providers. Scores have been shown to correlate with 30-day patient mortality; those with a Pmort30 score of 1 have the highest predicted mortality (and therefore the highest priority in the ED), whereas patients with Pmort30 scores of 4 to 5 are typically observation-level patients. The latter tend to have hospital lengths of stay of less than 48 hours and were most likely the patients who were safely discharged home. Pmort scores were calculated for all ED and hospital patients but did not serve as a decision point for ED implementation of the AFib algorithm. The scores were used only retrospectively for the purposes of analysis.

Our treatment focused on rate control, although electrical cardioversion was considered in appropriate patients. Given our local practice pattern, chemical cardioversion is not typically performed in our ED. Patients were treated with oral beta-blockers or calcium channel blockers, 50 mg metoprolol BID or 120 or 180

mg diltiazem daily. Occasionally, providers chose to administer an IV bolus of these medications while in the ED but providers were discouraged from starting IV infusions. Patients who received an IV bolus without an infusion were still considered for ED discharge. Lenient rate control was encouraged. A heart rate less than 110 beats/min was encouraged as ideal prior to discharge.[13] However, clinicians ultimately determined when patients were appropriate for discharge.

As the intention was to create a safe, uncomplicated pathway for providers to use in a busy ED, the decision was made to defer anticoagulation and cardiac imaging (i.e., echo) until the outpatient cardiology visit. Because patients discharged from the ED appear to have a low short-term stroke risk, we advised deferring initiation of an anticoagulant in most patients, although the decision to begin anticoagulation was ultimately left to the ED clinician.[9,14] Patients started on or already taking anticoagulants were still included in the pathway. Patients discharged from the ED received prescriptions for rate-controlling agents, as well as educational pamphlets and pocket cards outlining their diagnosis and indications for ED return.

Cardiologists were not routinely consulted, nor did they generally evaluate patients in the ED. However, the on-call cardiologist was available for consultation if needed. A key component of "buy-in" from the ED physicians was assurance of close outpatient follow-up. A specific clinic, the AFib clinic, was created within the general cardiology outpatient clinic, with the understanding that discharged ED patients would receive follow-up within 3 business days. Several clinic slots with electrophysiology advanced practice providers or physicians were reserved daily for AFib patients discharged from the ED. No additional staff or office space was required for its creation. During regular business hours, the ED clerk was able to obtain an appointment time while the patient was still in the ED. Otherwise, the patient was contacted by the AFib clinic staff the following business day. In that setting, patients received extensive education and counseling regarding risk versus benefit of anticoagulation in the AFib clinic. Decisions regarding anticoagulation, as well as imaging and ultimate treatment strategy, were provided in the AFib clinic by an electrophysiologist.

Significant culture change was required to move toward a less aggressive approach. Prior to our algorithm, the treatment of rapid AFib at our institution involved almost reflexive administration of IV infusions to achieve rate control, followed by admission to the hospital. Patients occasionally received electrical cardioversion, but this decision was dependent on individual cardiologist and ED clinician practices. In the months prior to initiation of our treatment algorithm, both ED and cardiology providers received considerable education regarding diagnosis and treatment expectations. Education occurred via various methods, including live lectures, e-mail, and a mandatory online module.

Data Analysis

We collected data retrospectively through electronic queries from clinical, pharmacy, and administrative databases. For individuals in each cohort, discharge diagnoses for return ED visits and hospital admissions were screened and flagged for a manual review of the medical record for any potential adverse event (mortality, myocardial infarction, cardiac arrest, heart failure, syncope, stroke, transient ischemic attack, hypotension, and shock). Return visits were defined as days from hospital or ED discharge. The Social Security Administration Death Registry was queried to capture any mortality not reported through our own health system. Each patient had only one index ED visit and occurred only once in the data. Analysis was performed on all patients who met inclusion criteria for the study, and an additional subanalysis was performed on low-acuity patients only, defined as having Pmort30 scores equal to 3, 4, or 5.

Baseline demographics and patient comorbidities were described with simple counts and percentages for categorical variables or means and standard deviations for interval variables. All covariates except age were categorical and entered as dummy variables. Differences between the pre and post samples were examined using chi-square tests for categorical variables and a t-test for age. The distributions of each variable were assessed for the possibility of incorrect data points or outliers. Lowess plots demonstrated a linear relationship between age and each of the outcomes. Although the examination of demographics and health histories only found a significant difference for history of congestive heart failure (CHF), we used logistic regressions to calculate odds ratios (ORs) after adjusting for all of the demographics and comorbidities. All analyses were conducted using R and Stata 14.[15,16]

RESULTS

For the 12-month study intervention period, there were 522 patients with a primary diagnosis of AFib

with rapid rate who were treated in accordance with the AFib algorithm. For the preintervention phase, there was baseline cohort of 586 patients. Table 1 describes the characteristics of these cohorts. There were no significant differences in patient demographics (age, sex, and race). We also evaluated baseline comorbidities between the control and intervention groups and found that only the presence of CHF (24.6% pre vs. 34.3% post) was significantly different ($p < 0.001$). No significant difference was found in acuity levels between the two cohorts.

Since the initiation of our algorithm in early 2015, hospital admissions for patients presenting with AFib/AFL decreased substantially. The admission rate (inpatient or observation status) dropped from 80.4% (471/586) to 67.4% (352/522), accounting for an absolute reduction in admissions of 13% ($p < 0.001$) and a relative risk reduction of 16.1%. Of the postimplementation cohort, 17.2% received cardioversion, and the remaining patients were treated with rate controlling agents, compared to 21.2% who received cardioversion in the preintervention group.

Our secondary outcomes compared the rate of ED return visits within 3 days and within 30 days of discharge home. Returns to the ED for any reason were included, regardless of whether they were related to the index visit for AFib/AFL. Despite the marked decrease in the admission rate, there was not an observed increase in ED return rates. The rate of patients returning to ED for any reason within 3 days of discharge from the index ED visit was fairly stable at 1.19% (March 2013–March 2014) and 1.0% (March 2015–March 2016; $p = 0.92$). Thirty-day ED returns were also stable at 3.8% before algorithm implementation compared to 3.6% afterward ($p = 0.99$). Review of the hospital records and Social Security Data Registry revealed no deaths of any of the study patients. We also considered change in 3- and 30-day readmissions just for those who were discharged without admission. However, the number of ED returns was very small in this subgroup. There was only one 30-day return in the discharge group during the postimplementation period and zero 3-day returns. The differences compared to discharged patients in the preimplementation period (three 30-day returns and one 3-day return) were not significant. We also found that the average ED length of stay for discharged patients was not significantly reduced (4.73 hours pre vs. 4.60 hours post).

We separately examined lower-acuity patients, as these were patients with an inherently greater potential for safe outpatient management. In this subset of patients, the number of patients admitted decreased from 63.6% (161/253) to 43.7% (94/215) with an absolute reduction of 19.9% ($p < 0.001$) and a relative risk reduction of 31.3%. After adjusting for the demographics and comorbidities in a logistic regression model (Table 2), there were significant group differences for hospital admissions. The OR for the cohort variable (OR > 1 meaning higher rates in the pre

Table 1
Patient Demographics and Comorbidities

	Mar 2013–Feb 2014 (n = 586)	Mar 2015–Feb 2016 (n = 522)	p-value
Age (years)	69.5 (□13.9)	70.9 (□13.7)	0.093
Sex			0.808
Male	286 (48.8)	250 (47.9)	
Female	300 (51.2)	272 (52.1)	
Race			0.75
African American	43 (7.3)	43 (8.2)	
White	538 (91.8)	473 (90.6)	
Other	5 (.9)	6 (1.1)	
Hx of CHF	144 (24.6)	179 (34.3)	< 0.001
Hx of CAD	173 (29.5)	156 (29.9)	0.947
Hx of DM	126 (21.5)	110 (21.1)	0.92
Hx of HTN	382 (65.2)	328 (62.8)	0.452
Low acuity	253 (45.7)	215 (42.6)	0.342

Data are reported as mean (□SD) or n (%).
CAD = coronary artery disease; CHF = congestive heart failure; DM = diabetes mellitus; HTN = hypertension; Hx = history.

Table 2
Logistic Regression for Hospital Admissions

			95% CI		
Predictor	OR	SE	Lower	Upper	p-value
Age	0.987	0.009	0.969	1.004	0.136
African American	0.818	0.305	0.394	1.698	0.589
Female	1.390	0.275	0.943	2.049	0.096
Diabetes	1.954	0.618	1.051	3.633	0.034
Low acuity	0.321	0.082	0.194	0.531	<0.001
Syncope	4.709	2.711	1.524	14.556	0.007
Hypertension	5.183	1.028	3.514	7.646	<0.001
CHF	33.595	20.638	10.078	111.991	<0.001
COPD	10.140	7.986	2.166	47.469	0.003
CAD	9.322	3.633	4.343	20.011	<0.001
Other comorbidity	5.423	5.966	0.628	46.852	0.124
Pre protocol	3.385	0.657	2.314	4.953	<0.001
Intercept	0.994	0.701	0.250	3.963	0.994

Note: Baseline category for race is white, "other race" is excluded due to small number. Model pseudo-$R^2 = 0.434$.
CAD = coronary artery disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease.

group) was significant, 3.4 (95% confidence interval [CI] = 2.3–5.0, $p < 0.001$), indicating that the odds of a hospital admission were about three and a half times larger before the algorithm was in place. At the same time, there were no cohort differences for the secondary outcomes in similarly specified logistic regressions. As a sensitivity analysis to deal with the potential of overfit outcomes with a small number of events in the secondary outcomes, we also tested models that adjusted only for CHF, which was the sole significant variable in Table 1. Significance was unaffected for the cohort variable in all three models. We also tested for a time trend in the pre data to determine if there was already a tendency toward reduced admissions prior to the protocol. With date of initial visit as the sole predictor, the estimate was nonsignificant (OR = 0.999, $p = 0.104$). The OR for the pre cohort variable in the logistic regression model of 3-day readmission was 1.0 (95% CI = 0.3–3.4, $p = 0.909$). For the 30-day readmission model, the OR was 0.9 (95% CI = 0.5–1.7, $p = 0.729$).

The AFib clinic recorded follow-up data using their outpatient electronic medical records system. Nearly 90% (88.5%) of patients referred to the clinic were seen in the following 3 business days. All of the remaining patients were contacted via telephone by clinic staff. Their reasons for not following up in the AFib clinic were generally because they preferred to follow up with their own primary care physician or an outside cardiologist. Feasibility issues precluded the collection of additional variables through the AFib clinic.

DISCUSSION

Hospitalization for patients presenting to the ED with AFib/AFL is an overused and expensive treatment approach in the United States. Escalating health care costs over the past several decades have highlighted the importance of seeking safe alternative outpatient treatment options.[3,4]

Emergency department rate control remains popular in the United States and is supported as a treatment option for acute AFib by the ACC and AHA.[9] In other jurisdictions, such as Canada, ED cardioversion followed by discharge to outpatient care is common.[4,6,7] A recent prospective cohort study by Stiell et al.[17] highlighted the success of discharge after ED cardioversion. However, this approach requires significant ED resources, and its associated adverse event rate is likely unacceptable in the practice environment in the United States. There were several issues with this study that would prevent widespread use of their algorithm. Almost 40% of the patients were excluded, as they were not eligible for their protocol because of unclear time of onset of the AFib/AFL. This is a very common problem with patients who present with this arrhythmia to the ED. The study had a very high 30-day ED return rate of 27.9% (15.4% because of issues with AFib/AFL) compared to our 30-day return rate of 3.6% postintervention. The 10.5% adverse event rate is unlikely to be acceptable at most institutions. Our study included all patients regardless of the duration of their AFib/AFL. Cardioversions were performed on only low-risk patients; most were already anticoagulated with confirmation of their anticoagulation but did not exclude patients who were not candidates for anticoagulation. In addition, we ensured follow-up before starting the patients on anticoagulation.

Previous studies have proposed the feasibility of an ED observation unit protocol for management of AFib and have shown that this is a reasonable alternative to hospital admission.[18] Only one prior study has explored the possibility of discharging patients with AFib/AFL from the ED to a specialty AFib outpatient clinic and avoiding hospitalization altogether. Elmouchi et al.[2] created an ED-based protocol for AFib with the aim of converting patients from AFib to normal sinus rhythm while in the ED and then discharging to a cardiology-based clinic, with follow-up within 3 business days. The protocol utilized both IV and oral rate control agents and initiated patients on anticoagulation (warfarin or dabigatran). Their trial resulted in low readmission rates, no thromboembolic complications at 90 days, improved quality of life, and high patient satisfaction. Our protocol provides a more simplified, practical, and reproducible approach with a primary goal of symptom control via rate control. IV rate control agents and IV infusions were avoided when possible. Deferment of anticoagulation and cardiac imaging to the outpatient setting also allowed for a more user-friendly algorithm for ED providers.

We identified several components that were keys to success of our program. Emergency providers partnered with cardiologists to develop common goals. As national guidelines do not offer clear admission criteria, our cardiologists used their clinical experience to identify four high-risk features. This is a limitation but is also a strength of our study. By defining high-risk

features, we were able to safely stratify high and low-risk cohorts composed of patients who were either to be admitted or safely discharged. These admission criteria require further validation. As has been previously emphasized, our algorithm is purposefully simple to maximize ED provider use and adherence. Existing decision aids, such as the AFFORD aid, require numerous variables and may be cumbersome for ED providers to reliably integrate into daily practice.[19] In the interest of patient safety and ED resource utilization, we elected to defer initiation of anticoagulation and advanced imaging. Certainly a large contribution to our success was the close follow-up with cardiology, allowing ED providers to feel more comfortable with discharge home. Similar carve-outs using existing resources are feasible in other hospitals and may improve comfort with outpatient management. Use of the Pmort30 score was helpful to our local practice but may not be required for the implementation our treatment approach at other institutions. The algorithm's pathway allows for modifications to fit other emergency medicine practice environments. Ongoing education in the form of electronic reminders and online refresher modules has continued periodically since inception. Finally, physician engagement was key to bringing about the culture change required for the success of our program.

LIMITATIONS

Several limitations of our study must be considered. This was a retrospective analysis evaluating outcomes for 1 year at a single site. As with any observational study, there is the possibility that unobserved confounders are affecting the results. With all pre/post studies there is the possibility of secular trends which interfere with the validity of the study, although we did not find evidence of any statistically significant trends in admissions prior to the implementation of the protocol. Additionally, the high-risk features determined by our cardiologists have not previously been validated. Prospective and randomized trials utilizing multiple sites would provide more robust investigations of our algorithm. Adverse events were not formally measured but inferred by the 3- and 30-day ED return and readmission rates. All patients, regardless of cardiology follow-up, were included in our analysis; however, only return visits to our health system were captured. It is possible that patients may have presented to other health care facilities, although the majority of surrounding urgent cares refer patients to our ED. This limitation may contribute to a potential underreporting of adverse events (except for mortality). Finally, our study did not focus on ED rhythm control, which we recognize is gaining greater popularity in the United States; rather patients were evaluated for rhythm versus rate control as outpatients.

CONCLUSIONS

Our hospital's atrial fibrillation initiative highlights the use of a practical, uncomplicated algorithm that demonstrated success in decreasing hospital admissions and preventing return visits to the ED. We believe components of our approach can be adopted and modified by other academic or community hospital systems, leading to improved resource utilization and significant cost savings. The use of this algorithm and our acuity stratification methods warrant further study.

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