ORIGINAL RESEARCH

Impact of a Multidisciplinary Treatment Pathway for Atrial Fibrillation in the Emergency Department on Hospital Admissions and Length of Stay: Results of a Multi-Center Study

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***Background*—**Variability in the management of atrial fibrillation (AF) in the emergency department (ED) leads to avoidable hospital admissions and prolonged length of stay (LOS). In a retrospective single-center study, a multidisciplinary AF treatment pathway was associated with a reduced hospital admission rate and reduced LOS. To assess the applicability of the AF pathway across institutions, we conducted a 2-center study.

***Methods and Results*—**We performed a prospective, 2-stage study at 2 tertiary care hospitals. During the first stage, AF patients in the ED received routine care. During the second stage, AF patients received care according to the AF pathway. The primary study outcome was hospital admission rate. Secondary outcomes included ED LOS and inpatient LOS. We enrolled 104 consecutive patients in each stage. Patients treated using the AF pathway were admitted to the hospital less frequently than patients who received routine care (15% versus 55%; $P<0.001$). For admitted patients, average hospital LOS was shorter in the AF pathway cohort than in the routine care cohort (64 versus 105 hours, respectively; $P=0.01$). There was no significant difference in the average ED LOS between AF pathway and routine care cohorts (14 versus 12 hours, respectively; $P=0.32$).

***Conclusions*—**In this prospective 2-stage, 2-center study, utilization of a multidisciplinary AF treatment pathway resulted in a 3.7-fold reduction in admission rate and a 1.6-fold reduction in average hospital LOS for admitted patients. Utilization of the AF pathway was not associated with a significant change in ED LOS. **(*J Am Heart Assoc*. 2019;8:e012656. DOI: 10.1161/JAHA.119.012656.)**

Key Words: atrial fibrillation • cardioversion • emergency department • oral anticoagulant

Hospital admissions are responsible for almost 75% of the $6.65 billion spent on the treatment of atrial fibrillation (AF) in the United States each year.[1–3] The rate of AF-related hospitalization events in the United States has increased over the past 10 years and currently exceeds 450 000 per year.[4–8] Approximately 70% of the patients who are hospitalized for AF are admitted through the emergency department (ED).[3,4,7]

Multiple data sources suggest increased ED utilization related to AF. Analysis of the Nationwide Emergency Department Sample revealed an increase in AF-related ED visits in the United States of more than 30% from 2007 to 2014.[8,9] Registry data have also revealed that patients in the United States who present to the ED with AF are admitted to inpatient units more than 60% of the time.[7–10] The progressive increase in AF-related ED visits and hospital admissions emphasizes the need for more-efficient strategies for managing AF.

There is evidence that AF can be treated safely and effectively in the ED without requiring hospital admission.[11,12] Several studies have shown that a treatment paradigm including cardioversion followed by a brief period of observation is a safe alternative to inpatient management.[13–15] Use of this type of treatment strategy can also reduce hospitalization-associated costs in AF management.[13] Moreover, AF-related admission rates in Canada, where the strategy of early cardioversion and discharge has been much more widely embraced by emergency physicians, is lower than in the United States.[10,14,16–18]

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Clinical Perspective

What Is New?

- This multicenter study demonstrates that utilization of a multidisciplinary treatment pathway for atrial fibrillation in the emergency department can reduce hospital admissions and length of stay.

What Are the Clinical Implications?

- Broad implementation of the atrial fibrillation treatment pathway described in this study has the potential to improve adherence with published guidelines for atrial fibrillation treatment and to reduce the cost of atrial fibrillation treatment.

We previously reported results from a multidisciplinary treatment pathway for AF in the ED. This AF pathway was designed to address 3 issues that can delay treatment of AF in the ED and lead to potentially avoidable admission: (1) involvement of a cardiologist late in the course of patient treatment; (2) delay in arranging for cardioversion even after it is determined to be the most appropriate treatment; and (3) challenges associated with arrangement of appropriate anticoagulation management.[15] The AF pathway addressed late involvement of a cardiologist through inclusion of cardiology consultation as soon as possible after the patient arrived in the ED and AF was identified as the principal clinical problem. The cardiology consultant served to shorten the time required to make care decisions and to facilitate cardioversion, when needed. Cardioversions were performed in either the ED or the electrophysiology laboratory, as needed, to minimize delay. Utilization of this AF treatment pathway, which was previously evaluated in a single tertiary care hospital, was associated with significant reductions in admission rate and hospital length of stay (LOS).[15] However, without a control group, we could not rigorously assess the causal effect of the intervention on clinical outcomes for patients. To further assess the generalizability of this intervention, we conducted a 2-center, prospective clinical study.

Methods

Anonymized data and materials will be made available at the Harvard Dataverse and will be accessible through the Dataverse site.

Study Design, Setting, and Participants

The design of the AF treatment pathway (Figure 1) and the design of the 2-center, prospective, 2-stage clinical study (Figure 2) were approved by the participating clinicians and the authors' institutional review board before the study was begun. The informed consent requirement was waived. We evaluated the AF treatment pathway during a 9-month period (June 27, 2016 to March 20, 2017) at 2 large tertiary care hospitals in the Northeastern United States.

During the first stage of the study (June 27, 2016 to October 4, 2016), AF patients who presented to the EDs at the participating institutions received routine care. During this baseline period, all patients who presented to the ED with AF as the primary problem were screened through review of their electronic health record (EHR). A total of 287 patients who met the inclusion criteria (Table 1) were screened. The first 104 patients who met the inclusion criteria and did not meet the exclusion criteria (Table 2) were enrolled consecutively (52 from each of the 2 participating institutions). The number of patients excluded according to each exclusion criterion is included in Table 2.

During the second stage of the study (October 5, 2016 to March 20, 2017), a total of 283 patients who presented with AF as the primary problem were screened. As in stage 1, the first 104 patients who met the inclusion criteria but did not

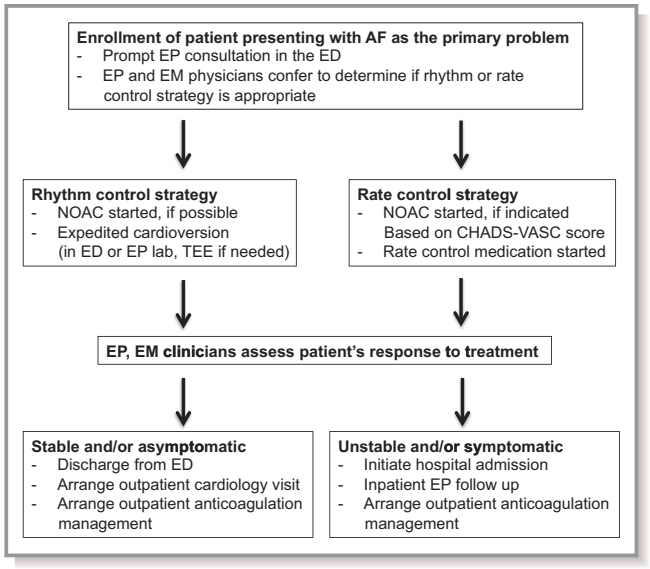

Figure 1. Diagram of the multidisciplinary AF treatment pathway. Prompt cardiac electrophysiology (EP) consultation was obtained for all enrolled patients. This was followed by discussion between the EP and emergency medicine (EM) clinicians to determine the appropriate treatment strategy (rhythm vs rate control). If a rhythm control strategy was chosen, the EP team assisted in expediting cardioversion. The EP team also assisted in the choice of the most appropriate anticoagulant irrespective of the choice of rhythm or rate control strategy. The EP and EM clinicians then assessed the patient's response to therapy and determined the patient's candidacy for discharge from the emergency department (ED). AF indicates atrial fibrillation; NOAC, novel oral anticoagulant; TEE, transesophageal echocardiography.

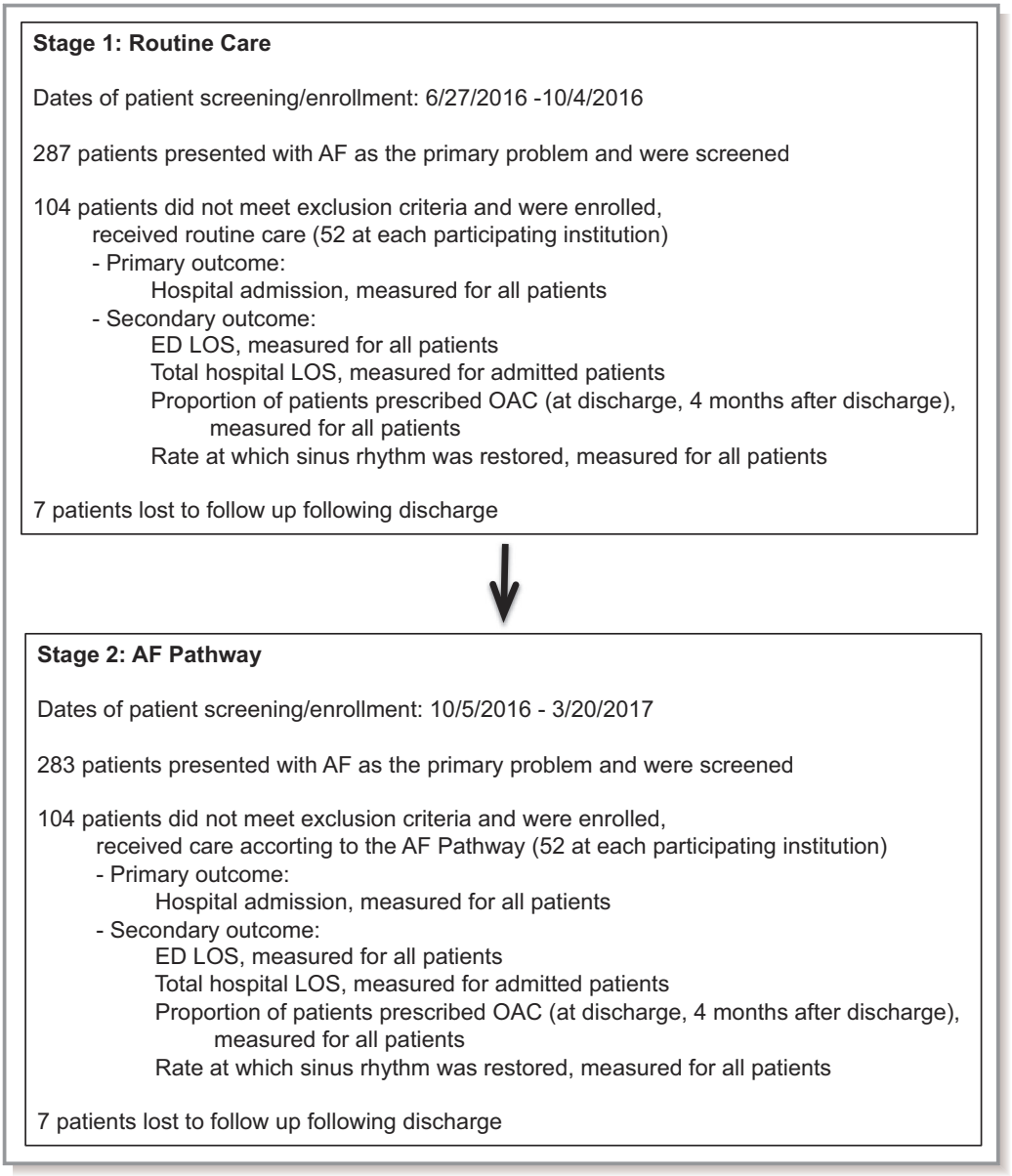

Figure 2. Design of the multicenter, prospective, 2-stage study of the AF treatment pathway. All patients presenting with AF to the ED at both participating institutions were screened for inclusion in the study. Patients were enrolled if they presented with AF as a primary problem, met the inclusion criteria, and did not meet the exclusion criteria. In stage 1 of the study, enrolled patients received routine care. In stage 2 of the study, enrolled patients were treated according to the AF pathway, as described in Figure 1. At the conclusion of the study, impact of the AF pathway on the primary and secondary study outcomes was determined. AF indicates atrial fibrillation; ED, emergency department; LOS, length of stay; OAC, oral anticoagulant.

meet the exclusion criteria were enrolled consecutively (52 at each institution). Patients enrolled during the second stage of the study were treated according to the AF pathway.

Intervention

The AF pathway, described in Figure 1, was the primary intervention performed in this study. The AF pathway did not mandate any specific treatments.

Data Sources and Collection

During both stages of the study, research coordinators reviewed the ED patient census every 8 to 12 hours and identified patients with AF as the primary problem. EHR for these patients were reviewed at that time. Patients who met the inclusion criteria and did not meet the exclusion criteria (according to data available in the EHR at the time of ED presentation) were enrolled. During the second stage

Table 1. Inclusion Criteria

Inclusion Criteria
Age 18 or older
AF as the primary diagnosis at the time of ED presentation

AF indicates atrial fibrillation; ED, emergency department.

of the study (AF pathway), patients who met criteria for enrollment were brought to the attention of the ED physicians.

We captured all patient data (eg, medical history, hospital admission status, hospital LOS, prescriptions, and interventions) through EHR review using a standard data collection form. Medical history data collected for each patient included the following: age, sex, hypertension, congestive heart failure, valve disease, history of transient ischemic attack/cerebrovascular accident, peripheral arterial disease, history of myocardial infarction, diabetes mellitus, hyperlipidemia, lung disease, and chronic kidney disease. Baseline characteristics of the study cohorts are included in Table 3.

For each enrolled patient, the EHR was reviewed again by study staff ≈1 month after initial ED presentation. At this time, data regarding patient outcomes (eg, admission status, LOS, and anticoagulant prescription) were collected. For each patient, the EHR was accessed again 4 months after the index presentation to calculate the number of AF-related return visits to the ED and calculate adherence to prescribed anticoagulation therapy.

Primary and Secondary Outcomes

The primary outcome measure for the study was hospital admission rate for AF patients treated in the ED. Secondary outcomes included in the study included the following. ED LOS was calculated for all patients. Total hospital LOS (ED LOS plus inpatient LOS) was calculated for patients who were admitted to inpatient units. The proportion of patients in each cohort appropriately prescribed oral anticoagulant (based on CHADS-VASC score, obtained from the EHR) was compared at the time of discharge and 4 months after discharge. In addition, rate of restoration of sinus rhythm was compared between cohorts. The proportion of patients in each cohort who were prescribed oral anticoagulants (OACs) in keeping with published guidelines was compared. Choice of specific OAC medications (novel oral anticoagulants [NOACs] versus coumadin) was analyzed, but was not a prespecified study outcome.

Table 2. Exclusion Criteria

Exclusion Criteria	No. of Patients Excluded per Criterion, Phase 1	No. of Patients Excluded per Criterion, Phase 2
AF secondary to an acute, noncardiac illness (eg, sepsis, thyroid storm)	44	30
Hypotension <90/50 mm Hg	15	22
Hypertension >180/110 mm Hg	14	8
History of New York Heart Association Class IV heart failure	0	0
Acute heart failure decompensation	20	30
Pulmonary edema	4	4
Acute coronary syndrome	6	10
Myocardial infarction <3 mo before presentation	2	0
Acute pulmonary embolism	2	2
Pulmonary embolism <3 mo before presentation	1	0
Acute exacerbation of chronic obstructive pulmonary disease	2	0
Uncorrected congenital cardiac anomaly	3	0
Cardiac surgery <3 mo before presentation	11	8
CVA/TIA	12	3
CVA/TIA <3 mo before presentation	2	0
Departure from the hospital against medical advice	3	4
Noncardiac medical problems that would interfere with same-day discharge	36	54
Psychiatric/psychosocial issues that would interfere with same-day discharge	6	4

AF indicates atrial fibrillation; CVA, acute cerebrovascular accident; TIA, transient ischemic attack.

Table 3. Baseline Characteristics of the Study Cohorts

Characteristics	Phase 1: Routine Care (N=104)	Phase 2: AF Pathway (N=104)	*P* Value
Age, mean (SD)	67.3 (13.6)	64.3 (14.3)	0.114
Male	50	53	0.677
Female	54	51	0.677
Hypertension	71	76	0.446
Congestive heart failure	26	24	0.746
Valve disease	15	21	0.271
History of cerebrovascular accident/transient ischemic attack	15	11	0.402
Peripheral arterial disease	6	6	1.000
Coronary artery disease	31	21	0.109
Previous myocardial infarction	13	7	0.158
Diabetes mellitus	20	12	0.124
Hyperlipidemia	48	51	0.677
Lung disease	11	19	0.114
Chronic kidney disease	17	10	0.149
CHADS-VASC Score, mean (SD)	3.0 (2.1)	2.6 (1.8)	0.996
HAS-BLED Score, mean (SD)	2.0 (1.3)	2.0 (1.1)	0.862

AF indicates atrial fibrillation.

Statistical Analysis

Sample size and power calculations were performed in the following manner. Based on patient volumes at both participating centers, we anticipated enrollment of at least 50 patients (from both participating centers combined) during each 4-month stage. Assuming 50 patients per cohort (routine care, AF pathway) and an alpha of 0.05, we estimated that there was sufficient power to detect differences in the proportion of patients hospitalized in each cohort (power 1.0 assuming hospitalization rates in the routine care and AF cohorts of 60% and 15%, respectively; power 0.98 assuming hospitalization rates in the routine care and AF cohorts of 60% and 25%, respectively). The hospitalization rates utilized in this power calculation were informed by an earlier study of the AF pathway.[15]

We present baseline characteristics of patients in both study cohorts with descriptive statistics, mean, and SD for continuous variables. We present categorical variables with counts or percentages. For each study cohort, we analyzed patients from both participating institutions as a single group. Comparison of baseline characteristics of patients in both cohorts was performed with a 2-tailed Student *t* test for continuous variables and a Pearson χ^2 test for categorical variables.

A Pearson χ^2 test was performed to compare all study outcomes involving categorical variables (eg, hospital admission rate, proportion of patients receiving appropriate OAC therapy, and rate of restoration of sinus rhythm). A Student *t* test was performed to compare study outcomes including continuous variables, except for hospital LOS and ED LOS, which were compared using the unequal variances T test. A Kaplan–Meier analysis was performed to estimate the probability of hospital discharge. For all statistical studies performed, we considered a 2-sided $P<0.05$ as significant. We performed analyses using the STATA software package (Release 15, 2017; StataCorp LP, College Station, TX).

Results

Patient Population

Baseline characteristics of the study cohorts (N=208) are displayed in Table 3. There were no significant differences in age, sex, or medical comorbidities between the 2 groups. AF was a new diagnosis for 38% of the enrolled patients in the routine care cohort and for 40% of the enrolled patients in the AF pathway cohort (Table 4). The proportion of patients with newly diagnosed AF was not significantly different between the 2 phases of the study ($P=0.777$).

AF was paroxysmal for ≈80% of enrolled patients with an established AF diagnosis (Table 5). The proportions of patients with paroxysmal and persistent AF were not significantly different between the 2 cohorts ($P=0.884$). The proportion of patients who had undergone previous cardioversion was also not significantly different in the 2 cohorts (16%

Table 4. Proportions of Enrolled Patients With New Versus Established Diagnosis of AF/AFL

	Phase 1: Routine Care (N=104)	Phase 2: AF Pathway (N=104)	*P* Value
New diagnosis of AF/AFL	40 (38%)	42 (40%)	0.777
Established AF/AFL diagnosis	64 (62%)	62 (60%)	0.777

AF indicates atrial fibrillation; AFL, atrial flutter.

in the routine care group, 21% in the AF pathway group; *P*=0.490). There was also no significant difference in the number of patients who had undergone an ablation for AF/atrial flutter in the 2 cohorts (13% in the routine care group, 15% in the AF pathway group; *P*=0.944). Approximately 30% of patients in both cohorts with an existing diagnosis of AF had been under the care of a cardiac electrophysiologist (*P*=0.903).

Hospital Admission Rate

AF pathway utilization was associated with a significant reduction in the rate of hospital admission (Figure 3A). The inpatient admission rate for patients in the AF pathway cohort was 15% compared with 55% for patients in the routine care cohort (*P*<0.001).

Hospital and ED LOS

Hospital LOS was significantly shorter for patients who were admitted after being treated according to the AF pathway in the ED (Figure 3B). Average hospital LOS was 64±32 hours for patients in the AF pathway cohort, as compared with 105±94 hours for patients in the routine care cohort (*P*=0.01). Median hospital LOS was 62 hours for the AF pathway cohort and 73 hours for the routine care cohort.

Table 5. Features of AF/AFL in Patients in Whom a Diagnosis was Established Prior to Study Enrollment

	Phase 1: Routine Care (N=64)	Phase 2: AF Pathway (N=62)	*P* Value
Paroxysmal AF	52 (81%)	51 (82%)	0.884
Persistent AF	12 (19%)	11 (18%)	0.884
Previous cardioversion	10 (16%)	13 (21%)	0.490
Previous ablation for AF/AFL	8 (13%)	9 (15%)	0.944
Previous involvement of cardiac electrophysiologist	20 (31%)	20 (32%)	0.903

AF indicates atrial fibrillation; AFL, atrial flutter.

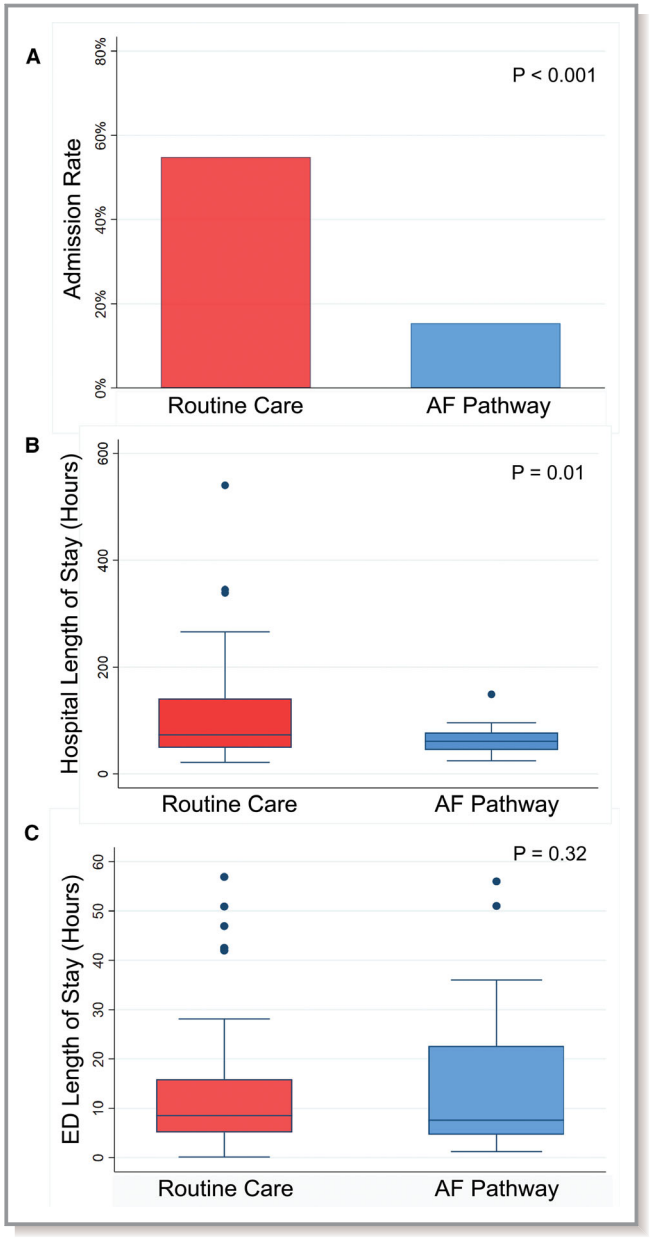

Figure 3. Impact of AF pathway utilization on inpatient admission rate and length of stay (LOS). A, Bar graph that describes hospital admission rates in the routine care and AF treatment pathway cohorts. Significantly fewer patients treated according to the AF pathway were admitted to an inpatient unit (*P*<0.001). B, Box plots that describe total hospital LOS (ED LOS plus inpatient LOS) for patients who were admitted from the ED to an inpatient unit. Box limits represent the first and third quartiles. The line within the box represents the median value. Whiskers represent the most extreme data points that are not more than 1.5 times the length of the box away from the box border. Circles represent outlier data points. Mean hospital LOS was significantly shorter for patients treated according to the AF pathway (*P*=0.01). C, Box plots that describe ED LOS for all patients, irrespective of admission status. Format of the box plots is the same as displayed in (B). There was not a statistically significant difference in time spent in the ED for the 2 study cohorts (*P*=0.32). AF indicates atrial fibrillation; ED, emergency department.

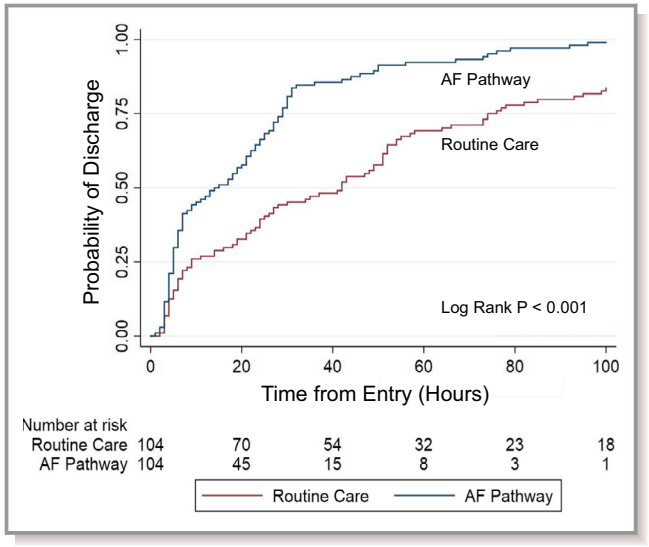

Figure 4. Kaplan–Meier estimate of the probability of discharge for patients in the AF pathway and routine care cohorts. Probability of discharge as a function of time after arrival in the ED was calculated for all patients in both study cohorts. Kaplan–Meier curves for the AF pathway and routine care cohorts reveal a significantly higher probability of discharge for patients treated according to the AF pathway (P<0.001). AF indicates atrial fibrillation; ED, emergency department.

ED LOS was not significantly different between the AF pathway and the routine care cohorts (Figure 3C). The average ED LOS was 14±11 hours for patients in the AF pathway cohort and 12±11 hours for patients in the routine care cohort (P=0.32). Median times were 8 hours (AF pathway) and 9 hours (routine care).

AF pathway utilization increased the probability of earlier discharge for all patients, irrespective of subsequent inpatient admission status (Figure 4). Time from initial presentation to the ED until hospital release was calculated for all patients in both cohorts. A Kaplan–Meier estimate of discharge probability revealed that the likelihood of discharge was significantly higher for patients in the AF pathway cohort than in the routine care cohort (66% versus 39% at 24 hours, 89% versus 56% at 48 hours; P<0.001). The odds ratio for hospital admission for the AF pathway versus routine care was 0.15 (P<0.001; 95% CI, 0.08–0.29).

Restoration of Sinus Rhythm

Utilization of the AF pathway was associated with a 15% increase in rate of sinus rhythm restoration (Table 6; P=0.017). Direct current cardioversion was used twice as often in the AF pathway cohort than in the routine care cohort (31% versus 15%, P=0.008). Rates of transesophageal echocardiography guidance for direct current cardioversion were not significantly different in the 2 cohorts. In the routine care cohort, 11 of 16 (69%) underwent transesophageal echocardiography guidance, as compared with 15 of 32 (47%) in the AF pathway cohort (P=0.152). Comparison of rates of chemical cardioversion and spontaneous cardioversion between the 2 cohorts did not reveal any significant differences.

Table 6. Impact of the AF Treatment Pathway on the Rate at Which Sinus Rhythm Was Restored

	Phase 1: Routine Care (N=104)	Phase 2: AF Pathway (N=104)	*P* Value
Sinus rhythm restored	63 (61%)	79 (76%)	0.017
Direct current cardioversion	16 (15%)	32 (31%)	0.008
Chemical cardioversion	4 (3.8%)	5 (4.8%)	0.733
Spontaneous cardioversion	40 (38%)	40 (38%)	1

AF indicates atrial fibrillation.

Adherence With AF Anticoagulation Guidelines

AF pathway utilization did not have a significant impact on adherence to anticoagulation guidelines.[19,20] The proportion of patients with an established diagnosis of AF who were prescribed OACs before study enrollment was not significantly different between the study cohorts (Table 7; P=0.873). There was also no difference between study cohorts with respect to proportion of patients with established AF who were prescribed OACs at the time of discharge (Table 7). Comparison of all patients revealed no difference between study cohorts with respect to the proportion of patients who qualified for OACs based on their CHADS-VASC score who were discharged with an anticoagulant prescription (Table 7; P=0.489). All patients were followed for 4 months after initial hospital discharge, and anticoagulation prescriptions were requeried at this point. In the routine care cohort, 78% of patients still had an active NOAC prescription, as compared with 88% in the AF pathway cohort. This difference was greater than the difference between cohorts at the time of discharge, but was not statistically significant (P=0.067).

Choice of OAC

OAC prescriptions were analyzed for all patients at hospital discharge. This analysis revealed that patients in the routine care cohort were prescribed coumadin almost twice as often as patients in the AF pathway cohort (28% versus 15%, P=0.029; Table 8). NOACs were prescribed less frequently to patients in the routine care cohort than to patients in the AF pathway cohort (49% versus 63%; P=0.036).

Table 7. Effect of the AF Treatment Pathway on Adherence to Anticoagulation Guidelines

	Phase 1: Routine Care	Phase 2: AF Pathway	*P* Value
Existing OAC prescription before ED presentation (patients with established AF)*	53/64 (83%)	52/62 (84%)	0.873
OAC prescription at discharge (all patients)*	92/104 (88%)	95/104 (91%)	0.489
OAC prescription 4 mo after discharge (all patients)*	81/104 (78%)	91/104 (88%)	0.067
Patients lost to follow-up (all patients, no visits after initial discharge)	7/104 (6.7%)	7/104 (6.7%)	1.0

CHADS-VASC 2 or higher: NOAC or coumadin. AF indicates atrial fibrillation; ED, emergency department; OAC, oral anticoagulant.
*CHADS-VASC 1: aspirin, NOAC, or coumadin.

Subgroup analysis was performed for patients with established AF (diagnosis of AF established before index ED presentation) and for patients with new AF (initial discovery of AF at the time of index ED presentation). A greater proportion of patients with established AF in the AF pathway cohort were prescribed NOACs at discharge (Table 8; *P*=0.017). Fewer patients in the AF pathway cohort with established AF were prescribed coumadin, but this difference was not statistically significant (*P*=0.487). For those patients with established AF who presented to the ED with an existing OAC prescription, there was no significant difference in coumadin or NOAC use between cohorts (*P*=0.627 and 0.215, respectively).

None of the patients with new AF (first diagnosis of AF at the time of index ED visit) had existing OAC prescriptions at the time of study enrollment (Table 8). At the time of discharge, coumadin was prescribed less frequently to new AF patients in the AF pathway cohort (*P*=0.003). A larger proportion of new AF patients in the AF pathway cohort were prescribed NOACs at discharge, but this difference was not statistically significant (*P*=0.666).

Return Visits to the ED After Index Presentation

The number of patients in each cohort who returned to the ED because of AF after the index presentation was not significantly different between the 2 study cohorts. We calculated the number of return visits to the ED because of AF within the first 4 months after the index presentation for each patient. The total number of patients who had at least 1 return visit to the ED during this period was calculated separately. Fewer patients in the AF pathway cohort returned to the ED because of AF, but this difference was not statistically significant (11 versus 17; *P*=0.223). The total number of AF-related

Table 8. Effect of the AF Treatment Pathway on the Choice of OAC

Patient Group	OAC prescription	Phase 1	Phase 2	*P* Value
All patients (established+new AF/AFL)	OAC prescription: at discharge			
	Coumadin	29/104 (28%)	16/104 (15%)	0.029
	NOAC	51/104 (49%)	66/104 (63%)	0.036
Patients with established AF/AFL	OAC prescription: before ED presentation			
	Coumadin	19/64 (30%)	16/62 (26%)	0.627
	NOAC	21/64 (33%)	27/62 (44%)	0.215
	OAC prescription: at discharge			
	Coumadin	19/64 (30%)	15/62 (24%)	0.487
	NOAC	31/64 (48%)	43/62 (69%)	0.017
Patients with new AF/AFL	OAC prescription: before ED presentation			
	Coumadin	0/40 (0%)	0/42 (0%)	1
	NOAC	0/40 (0%)	0/42 (0%)	1
	OAC prescription: at discharge			
	Coumadin	10/40 (25%)	1/42 (2%)	0.003
	NOAC	20/40 (50%)	23/42 (55%)	0.666

AF indicates atrial fibrillation; AFL, atrial flutter; NOAC, novel oral anticoagulant; OAC, oral anticoagulant.

return visits to the ED was higher for the AF pathway cohort than the routine care cohort (29 versus 14; P=0.010). Given that the total number of patients who returned to the ED because of AF was not significantly different between cohorts, the higher number of total visits in the routine care cohort was driven by a small number of patients who visited the ED on multiple occasions.

Discussion

This 2-center, prospective, 2-stage study produced several observations regarding a multidisciplinary strategy for treatment of AF in the ED. Utilization of the AF treatment pathway resulted in a 3.7-fold reduction in admission rate as compared with routine care (Figure 3A). For patients who were admitted to inpatient units, AF pathway utilization was associated with a 1.6-fold reduction in hospital LOS (Figure 3B). Average time spent in the ED was not significantly different for the AF pathway and the routine care cohorts (Figure 3C). Sinus rhythm was restored more frequently with the AF pathway than with routine care (Table 6). The number of patients who received appropriate OAC therapy was not significantly different between the study cohorts either during the initial presentation or during a 4-month follow up period (Table 7). Use of NOACs was higher in the AF pathway (Table 8). There was no significant difference in the number of patients in each study cohort who returned to the ED for AF within 4 months of the index presentation.

The AF Pathway Was Associated With Reduction in Admission Rate

The AF pathway was designed to maximize the efficiency of AF management in the ED, without mandating treatment decisions. The inpatient admission rate associated with the AF pathway described in this study was 15%. This is lower than many previously published studies.[15,21–25] The only reported AF treatment protocols with lower admission rates specified rigid treatment strategies, which could limit applicability to a wide patient population.[21–25] For example, the Ottawa Aggressive Protocol, which involved intravenous procainamide administration for all patients with an option for electrical cardioversion in the ED if procainamide did not restore sinus rhythm, was associated with a 3% inpatient admission rate.[21] An older protocol that specified use of intravenous procainamide in the ED reported a 6% inpatient admission rate.[22] An additional AF treatment protocol, which specified that AF patients be managed in ED observation units, was associated with a 12% inpatient admission rate.[23] In a pilot evaluation of the AF treatment pathway described in this study, the admission rate was 16%.[15]

The AF Pathway Was Associated With an Increase in the Proportion of Patients Prescribed NOACs

A large proportion of patients in both study cohorts received guideline-appropriate prescriptions for OACs at the time of discharge (88% for the routine care cohort and 91% for the AF pathway cohort; P=0.489).[19,20] For patients in the AF pathway cohort, there was a trend toward an increase in adherence with anticoagulation guidelines 4 months after index presentation, but statistical significance was not achieved (Table 7). The absence of a significant increase in OAC use in the AF pathway cohort is likely explained by the fact that it was implemented in a tertiary care center, where most practitioners are highly informed of the guidelines for anticoagulation treatment. Only 1 previously reported AF treatment pathway was specifically designed to enhance guideline-based initiation of OAC therapy for patients presenting to the ED with AF.[26] Utilization of this treatment strategy was associated with a lower rate of guideline-appropriate utilization of OAC (70%) than was observed in either cohort in our study.

One interesting finding in our study is that the proportion of anticoagulated patients who were prescribed NOACs, instead of coumadin, at discharge was significantly higher in the AF pathway cohort than in the routine care cohort (63% versus 49%; Table 8). Achieving therapeutic anticoagulation is more rapid and straightforward with NOACs than with combined use of coumadin and heparin products. Increased utilization of NOACs in the AF pathway was likely an important contributor to the lower admission rates and decreased hospital LOS.

The AF pathway was designed to address logistical challenges associated with initiation of OAC therapy, but did not mandate the use of a specific OAC agent. The choice of OAC agent (coumadin versus NOAC) was made by the responsible clinician. This study was not designed to address the specific reasons responsible for the choice of NOACs over coumadin. In addition, subgroup analysis did not demonstrate that the increase use of NOACs was clearly driven by patients with new versus established AF. Further study will be required to address this issue.

Sinus Rhythm Was Restored More Frequently in Patients Treated According to the AF Pathway

According to the AF pathway described in this study, a rhythm control strategy was pursued only when the managing clinicians decided that this was the most appropriate course of action. Even so, sinus rhythm was restored more often for patients in the AF pathway cohort (76%) than the routine care cohort (61%; P=0.017).

Other protocols have reported higher rates of sinus rhythm restoration, but most specify a rhythm control strategy. For

example, the Ottawa Aggressive Protocol, which was structured to facilitate cardioversion, led to restoration of sinus rhythm in 93% of patients.[21] The rate of sinus rhythm restoration in another AF treatment protocol that specifies use of cardioversion in an ED observation unit setting was 85%.[23] Another ED observation-unit–based treatment protocol that did not specify a rhythm control strategy produced a sinus rhythm restoration rate of 82%.[24] An older, procainamide-based AF treatment protocol was based with a lower rate of sinus rhythm restoration (52% for atrial fibrillation, 28% for atrial flutter) than our study.[22]

AF Relapse Leading to ED Return

Relapsed AF has been reported after ED-based cardioversion and discharge. Reported rates of return ED visits for AF vary between 3% and 17%.[11] In our study, 11% of patients treated according to the AF pathway returned to the ED because of AF within 4 months of initial presentation. This was not significantly different than the AF-related ED return for patients in the routine care cohort (16%; P=0.223).

Conclusions

The AF pathway described in this study resulted in reduction of admissions of patients presenting to the ED with AF. The improved efficiency of patient care was achieved by early involvement a cardiology consultant after the patient's arrival in the ED, expedited cardioversion when appropriate, and utilization of NOACs, whenever possible, for patients who qualify for OAC therapy. This study builds upon previously reported AF treatment strategies, which have demonstrated that discharge of AF patients from the ED can be a safe alternative to inpatient admission, even when a rhythm control strategy (including cardioversion) is utilized.[11,13,23]

Broad implementation of the multidisciplinary AF treatment pathway described in this multicenter study has the potential to reduce the cost of AF treatment.[3] In addition, this AF pathway may represent an opportunity to decrease variation in adherence with published guidelines for AF management, including the guidelines for anticoagulation.[18,27–30] Additional prospective, multicenter studies will be needed to further validate the impact of this multidisciplinary AF pathway on patient outcomes. Other multicenter studies examining other strategies for AF management in the ED have been reported, but these studies are either observational or retrospective.[31,32] There are not yet any completed, randomized control trials describing a multidisciplinary AF treatment pathway.[33]

Limitations

The limitations of this study include the small size of the patient cohorts. Sample size limited statistical validation of some outcomes, including rate of return visits to the ED after index presentation. Another limitation is the nonrandomized study design. Given the magnitude of the decrease in admission rate associated with the AF pathway in the single-center study, enrollment in a randomized study would have been very difficult. Study observations were also not adjusted for confounders. Inclusion of academic tertiary care centers in this multicenter study may limit applicability of the findings in other settings, particularly nonacademic and community medical centers, in which all the resources used in the AF pathway (such as an electrophysiology consult service) may not be available.

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