Likelihood of Spontaneous Cardioversion of Atrial Fibrillation Using a Conservative Management Strategy Among Patients Presenting to the Emergency Department

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Numerous emergency department (ED) atrial fibrillation (AF) protocols have been developed to reduce hospitalizations, focusing on the use of cardioversion in the ED. An alternative strategy of rate control with early specialty follow-up may be more widely applicable. The likelihood of spontaneous cardioversion with such a protocol is unknown. Between 2015 and 2018, 157 patients who presented to the ED with a primary diagnosis of AF and were hemodynamically stable and with low to moderate symptom severity were discharged with early follow-up at an AF specialty clinic. Rhythm at short-term (within 72 hours), within 30-day follow-up, and need for electrical cardioversion was tabulated. Various demographic and co-morbidity variables were assessed to determine their association with likelihood of spontaneous cardioversion. At an average of 2.3 days, 63% and within 30 days, 83% had spontaneous cardioversion. By 90 days, only 6.3% required electrical cardioversion. Diabetes (38% vs 69%, p <0.01), coronary artery disease (39% vs 66%, p = 0.02), reduced ejection fraction (40% vs 72%, p <0.01), dilated right atrium (43% vs 73%, p <0.01) and moderate-to-severely dilated left atrium (38% vs 78%, p <0.01) predicted those who were less likely to convert to sinus rhythm. Most patients who present to the ED with AF will spontaneously convert to sinus rhythm by short-term (2 to 3 days) follow-up with a rate control strategy. In conclusion, aggressive use of electrical cardioversion in the ED may be unnecessary in hemodynamically stable patients without severe symptoms. **(Am J Cardiol 2019;124:1534−1539)**

Atrial fibrillation (AF) is a significant burden to the United States healthcare system with a large proportion due to the cost of AF hospitalizations.[1] The rate of hospitalization has remained steady at 64% to 85% despite numerous studies of emergency department (ED) or observation unit protocols.[2−5] As a result, many strategies to prevent AF admissions have focused on the use of ED pharmacologic or electrical cardioversion.[6,7] Protocols utilizing ED cardioversion, however, rely on ED expertise with antiarrhythmic agents or ED resources for electrical cardioversion. Cardiology subspecialty consultation in the ED is often necessary which may be less feasible in rural environments.[8,9] An alternative strategy of rate control followed by early specialty follow-up for patients without severe symptoms or hemodynamic compromise has been shown to be an alternative strategy which may be widely applicable.[10] The likelihood of spontaneous cardioversion with such a protocol is unknown. The aim of this study was to determine the rhythm outcome of patients who are discharged from the ED to an early follow-up AF specialty clinic using a novel triage protocol.[10] Patients were followed to determine the percentage who would spontaneously convert to sinus rhythm and the percentage who would ultimately undergo electrical cardioversion. Additional goals of the study were to determine if there are specific predictors of spontaneous conversion and to confirm that a rate control strategy with early follow-up is safe with low rates of ED representation.

Methods

Patients included in this study were all those who presented to the ED at the University of North Carolina (UNC)

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between July 2015 and September 2018 with a primary diagnosis of AF or atrial flutter and who were treated utilizing a novel AF treatment protocol. In brief, patients who were considered hemodynamically stable and of low-to-moderate symptom severity were discharged with an early follow-up appointment to a local AF clinic, typically scheduled in 1 to 2 business days. The AF "transitions" clinic was staffed by a nurse practitioner or clinical pharmacist with supervision by a cardiologist or electrophysiologist. Patients were considered hemodynamically stable if their heart rate was <130 beats per minute and mean arterial pressure was >55 mm Hg with or without rate-controlling medication (Figure 1).[10] Low-to-moderate symptom burden was defined as a Severity of Atrial Fibrillation score ≤3 (Table 1).[11] Patients were excluded if they did not meet the criteria for discharge, were admitted, did not follow-up as scheduled, or received either electrical or pharmacologic rhythm control in the ED.

The main outcome variable was rhythm at the time of follow-up after ED presentation. Rhythm was determined based on electrocardiography. Rhythm was assessed at transition clinic follow up appointment, typically 48 to 72 hours after ED presentation. Patients who remained in AF were then scheduled for a follow-up appointment in the AF clinic or with a cardiologist within 30 days. Rhythm was reassessed at this visit using electrocardiography. Patients who remained in AF would then be scheduled for cardioversion if the cardiologist felt this was appropriate. The total number of patients who underwent electrical cardioversion within 90 days from initial ED visit was tabulated. The clinic had additional protocols to manage disease-specific co-morbidities associated with AF such as thyroid disease and alcohol abuse.

Various demographic and co-morbidity variables were assessed to determine whether they were associated with a likelihood of spontaneous cardioversion in follow up.

Table 1
Severity of atrial fibrillation score[11]

Class 0 − Asymptomatic with respect to AF
Class 1 − Symptoms attributable to AF have minimal effect on patient's general quality of life
Minimal and/or infrequent symptoms
Single episode of AF without syncope or heart failure
Class 2 − Symptoms attributable to AF have a minor effect on a patient's general quality of life
Mild awareness of symptoms in patients with persistent/permanent AF
Rare episodes in patients with paroxysmal or intermittent AF
Class 3 − Symptoms attributable to AF have moderate effect on patient's general quality of life
Moderate awareness of symptoms on most days in patients with persistent/permanent AF
More common episodes or more severe symptoms, or both, in patients with paroxysmal or intermittent AF
Class 4 − Symptoms attributable to AF have a severe effect on a patient's general quality of life
Very unpleasant symptoms in patients with persistent or paroxysmal AF
Frequent and highly symptomatic episodes in patients with paroxysmal or intermittent AF
Syncope thought to be due to AF
Congestive heart failure secondary to AF

The majority of co-morbidities were determined by either ICD-10 codes in the patient's problem list at time of the transition clinic or diagnoses documented in the transition clinic note. Body mass index was calculated by kg/m^2. Obesity was defined as a body mass index ≥30. Patients were considered to have obstructive sleep apnea if they already carried this diagnosis or if they screened positive based on the STOP questionnaire.[12] Heavy alcohol use was determined by the National Institute on Alcohol Abuse and Alcoholism guidelines.[13] Whether binge drinking specifically precipitated episodes of AF was not clearly

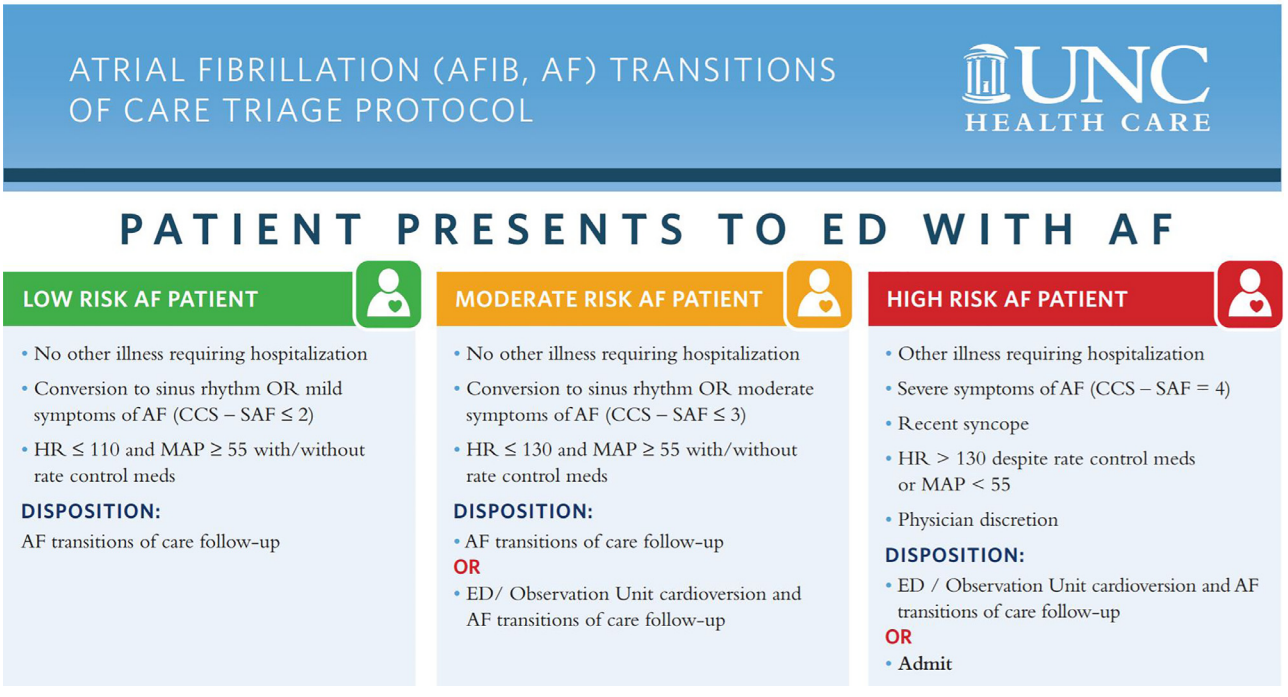

Figure 1. Protocol for triaging patients presenting to the ED with AF.

documented. The presence of structural heart disease was included if a patient underwent a transthoracic echocardiogram within 1 year before or 1 year after ED visit. Echocardiographic measures were based on American Society of Echocardiography guidelines.[14] Of the 123 patients who had an echo, 34 had one before diagnosis. The presence of structural heart disease was not part of the admission protocol, but was used prognostically in the clinic to determine the necessity of additional interventions. Repeat presentation to the ED for a primary diagnosis of AF within 30 days was tabulated. Per the protocol, decisions on anticoagulation were deferred to the AF transition clinic.

Univariate statistics were used to examine frequency distributions for categorical variables and means, standard deviations, and shapes of distributions for continuous variables. Likelihood of spontaneous cardioversion to sinus rhythm and use of pharmacologic or electrical external cardioversion was tabulated at each follow-up visit. Bivariate statistics was used to compare demographic and co-morbidity variables with likelihood of spontaneous cardioversions. Chi-square analyses were used for categorical variables and student's *t* Test for continuous variables. The UNC Institutional Review Board approved the study protocol.

Results

During the 2.5 years since the novel pathway of care was introduced, 157 patients were included in the study. In total, 178 patients were referred to the clinic. Of those, 18 did not attend the clinic as scheduled and 3 received an antiarrhythmic therapy in the ED. Based on previous analyses, the patients discharged to the AF clinic represent approximately 1/3 of patients presenting to the ED with a primary diagnosis of AF over the course of the study period.[10] The mean age was 65 years with a range of 25 to 100. The cohort was predominantly male and Caucasian. The average patient had a Severity of Atrial Fibrillation score indicating mild-moderate AF symptom severity. The majority of patients were overweight, with a significant portion obese. A majority of patients did not have a history of AF at the time of ED visit. The average time between ED visit and transition clinic follow up was 2.3 days. Anticoagulation was indicated in 103 of the patients, with 69 already on anticoagulation before presenting to the ED. Initiation of anticoagulation for the remaining 34 patients was deferred to the AF transition clinic. No patients in the cohort had undergone AF ablation in the previous 90 days. Additional demographic data is available in Table 2.

By the time of presentation to the AF transition clinic, most patients had spontaneously converted to sinus rhythm. Of the patients who were still in AF, 21 did not have a 30-day follow-up appointment in the UNC health system. By 30 days, a greater majority of patients had spontaneously converted to sinus rhythm. Only a small percentage of the original cohort ultimately underwent electrical cardioversion (Figure 2).

Patients with structural heart disease, including a reduction in left ventricular ejection, dilated right atrium, and moderate-severe left atrial dilation were less likely to spontaneously convert by the transition clinic appointment. In addition, diabetic patients and those with coronary artery disease were less likely to convert to sinus rhythm (Table 3). Of the 157 patients that were discharged from the ED to the transition clinic, 4 represented to the ED within 30 days for a primary diagnosis of AF. Two were still in AF at the

Table 2
Patient characteristics (n = 157)

Time from ED to transition appointment	Average (Stdev)	2.3 (2.3)
Age (years)		
Mean (Range) ± Standard Deviation		65 (25-100) ± 15
Men		87 (55%)
White		118 (75%)
Black		27 (17%)
Hispanic		3 (2%)
Other		9 (6%)
Body mass index (kg/m^2)		
<18.5		3 (2%)
18.5-24.9		35 (22%)
25.0-29.9		53 (34%)
>30.0		66 (42%)
Previous atrial fibrillation diagnosis		60 (38%)
Hypertension		105 (67%)
Type 2 diabetes mellitus		29 (18%)
Hyperlipidemia		47 (30%)
Obstructive sleep apnea		29 (18%)
Alcohol use		85 (54%)
Heavy alcohol use*		21 (13%)
Current tobacco abuse		10 (6%)
Chronic obstructive pulmonary disease		4 (3%)
Hyperthyroidism		4 (3%)
Hypothyroidism		4 (3%)
Heart failure reduced ejection fraction		20 (13%)
Heart failure preserved ejection fraction		6 (4%)
Coronary artery disease		18 (11%)
Mechanical valve		0 (0%)
Previous atrial fibrillation or atrial flutter ablation (%)		4 (3%)
CHA_2DS_2-VASc		2.4
Ejection fraction		
>55%		103 (65%)
35-50%		17 (11%)
<35%		3 (2%)
No echo/not documented in echo		34 (22%)
Left atrial size		
Normal		51 (32%)
Mild		27 (17%)
Moderate		17 (11%)
Severe		12 (8%)
No echo/not documented in echo		50 (32%)
Right atrial size		
Normal		92 (58%)
Mild		22 (14%)
Moderate		4 (3%)
Severe		1 (1%)
No echo/not documented in echo		38 (24%)
Emergency department intervention		
None		73 (46%)
Diltiazem		49 (31%)
Metoprolol		30 (19%)
Diltiazem and Metoprolol		5 (3%)
Adenosine		2 (1%)
Severity of atrial fibrillation (SAF) scale (n = 155)		
Average (Range)		1.6 (0-3)
St Dev		1.1

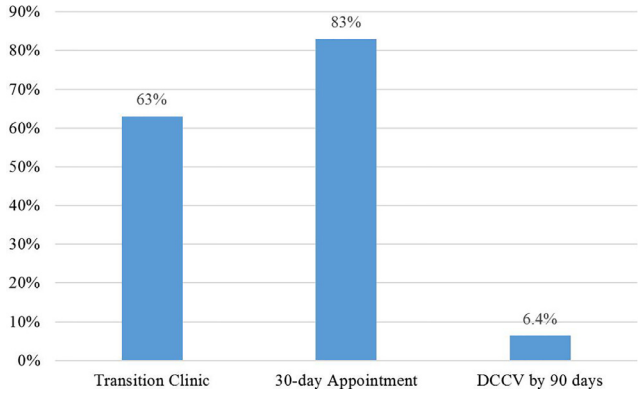

Figure 2. Percentage of patients with spontaneous conversion to sinus rhythm at short-term follow-up appointment (n = 157) and 30-day follow-up appointment (n = 136), as well as the percentage of patients who underwent electrical cardioversion by 90 days. DCCV = direct current cardioversion.

transition clinic whereas 2 had spontaneously converted and had a recurrent episode of AF.

Discussion

The primary finding of our study is that a majority of patients who present to the ED with a primary diagnosis of AF and who are hemodynamically stable will spontaneously convert to sinus rhythm by short-term follow up. Additional proportion will spontaneously cardiovert by 30-day follow up. The number of patients that ultimately underwent external cardioversion was low. Structural heart disease, coronary artery disease, and diabetes mellitus correlated with lower rates of spontaneous conversion. The ED representation rate was only 2.5%. This study suggests that aggressive use of external cardioversion to treat AF patients in the ED who are hemodynamically stable and not severely symptomatic is unnecessary as the vast majority can be managed with a rate control strategy and early follow-up.

Based on previous data from the Agency for Healthcare Research and Quality, the cost per hospitalization for AF in North Carolina is ~$24,000. The charge for an AF transition clinic appointment is $176, although a majority of patients will have insurance with a co-pay. The approximate charge for an elective cardioversion is ~$22,000, however only a small number of patients required the procedure and the majority of patients will have insurance and pay only a small proportion of the charge. Overall, the protocol and outpatient clinic likely leads to significant cost savings for both the patient and hospital system without needing major changes in typical ED management of AF.

A recent European study similarly found that delayed cardioversion is a viable alternative to early cardioversion.

Table 3
Correlation between patient characteristics and conversion to sinus rhythm at transition clinic appointment

	Normal sinus rhythm	Atrial fibrillation/atrial flutter	N	p Value
Men	60%	40%	87	0.34
Women	67%	33%	70	
Age (years)				
<65	69%	31%	67	0.21
>65	59%	41%	90	
White	59%	41%	118	0.02
Black	85%	15%	27	
Hispanic	67%	33%	3	
Other	33%	67%	9	
History of atrial fibrillation	58%	42%	60	0.33
Hypertension	60%	40%	105	0.26
Diabetes mellitus	38%	62%	29	<0.01
Body mass index >30 kg/m^2	65%	35%	66	0.61
Alcohol use	62%	38%	85	0.84
Heavy alcohol use	57%	43%	21	0.54
Current smoker	70%	30%	10	0.64
Coronary artery disease	39%	61%	18	0.02
Reduced ejection fraction	40%	60%	20	<0.01
Preserved ejection fraction	72%	28%	103	
Left atrial dilation	57%	43%	51	0.10
No left atrial dilation	73%	27%	56	
Moderate to severe left atrial dilation	38%	62%	29	<0.01
Mild to no left atrial dilation	76%	24%	78	
Right atrial dilation	43%	57%	28	<0.01
Severity of symptoms				
SAF Score 0-2	64%	36%	128	0.61
SAF Score 3	60%	40%	25	
Emergency department rate control				
No rate control	63%	37%	73	0.58
Diltiazem	71%	29%	49	
Metoprolol	57%	43%	30	
Diltiazem and Metoprolol	60%	40%	5	

In a study by Pluymaekers et al, patients who presented to the ED in AF were either cardioverted or discharged to a clinic within 24 hours.[15] Those still in AF were then referred back to the ED for cardioversion. This study found similarly high rates of spontaneous conversion at the early visit and high rates of sinus rhythm at 30 days. There are important differences between these 2 studies. First, their study excluded patients who were in AF for longer than 24 hours whereas our study did not require the treating physician to know the duration of AF. Second, our protocol allowed for patients to be discharged with a heart rate <130 as opposed to <110 in their study. Third, our study sought to determine what co-morbidities were associated with a failure to convert. Lastly, our study followed patients longer before cardioversion and therefore showed that a significant portion of patients will cardiovert spontaneously by 30 days. Despite these differences, both studies provide evidence that aggressive rhythm control in the ED may not be necessary.

The few studies that have looked at the spontaneous conversion after ED visit have been small in scale and were not part of an ED protocol. Vinson et al found that 11 of 16 (69%) patients who opted not to undergo electrical cardioversion in the ED converted at home within 24 hours.[16] Another study of 35 patients presenting to the ED found the rate of spontaneous cardioversion by 4 weeks to be 63%.[17] The conversion rate in our study, at 63% in approximately 48 hours and 83% within 30 days, is currently the largest study that has evaluated spontaneous conversion after ED visits and demonstrates that such a strategy could be widely applicable.

The viability of a rate-control and early follow-up ED protocol was also supported by the low ED representation rate. This is consistent with many other studies of AF which have shown the safety of discharging hemodynamically stable patients regardless of whether they are in sinus rhythm.[2,18,19] An important part of the protocol used in this study was early follow up. Atzema et al found that the most important risk factor for 14-day readmission was lack of follow up. In this study, there was no significant difference in 14-day repeat ED presentation between a rate or rhythm control ED strategy.[19] Similarly, the most important risk factor for 90-day mortality for AF patients in the ED was lack of follow up. And again there was no significant difference in whether a patient had undergone external ED cardioversion compared with those that did not.[20]

Previous studies of hospitalized patients have attempted to determine what factors are associated with spontaneous cardioversion. Shorter duration of AF has been an independent predictor of spontaneous conversion in several studies.[21–23] Unfortunately, AF duration was not clearly documented and therefore could not be included in the analysis. Danias et al found that reduced EF, but not increased left atrium size, correlated with lower spontaneous conversion rates; Tejan-Sie et al found the opposite.[21,22] Choudhary et al found neither measure correlated.[23] Our study demonstrated that structural heart disease was associated with lower rates of spontaneous conversion. Structural heart disease is associated with an increased risk of persistent AF and thus could be expected to predict a lower likelihood of spontaneous cardioversion.[24]

There are several limitations of this study. First, this protocol exclusively applies to patients that are hemodynamically stable with moderate or less symptoms of AF. Furthermore, patients should not have other diagnoses which may be associated with AF which necessitate hospitalization. Second, an essential component of this protocol is the need for comprehensive training of ED providers on the triage and management protocol and early follow-up at a specialty AF transitions clinic. Third, this protocol was enacted at a single academic medical center hospital with receptive ED providers and a homogenous homogeneous patient population. It is unclear whether this protocol would easily translate to rural community hospitals.

In conclusion, we demonstrate that using a conservative rate-control and early follow-up protocol for patients with AF who are hemodynamically stable and without severe symptoms obviates the need for ED or hospital cardioversion in the majority of patients. A conservative protocol of rate control and early follow up reduces both cost and unnecessary procedures. Future studies are underway to evaluate whether this type of protocol for care is applicable more broadly to community hospitals.

Disclosures

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