

Implementation of an emergency department atrial fibrillation and flutter pathway improves rates of appropriate anticoagulation, reduces length of stay and thirty-day revisit rates for congestive heart failure

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ABSTRACT

Objectives: An evidence-based emergency department (ED) atrial fibrillation and flutter (AFF) pathway was developed to improve care. The primary objective was to measure rates of new anticoagulation (AC) on ED discharge for AFF patients who were not AC correctly upon presentation.

Methods: This is a pre-post evaluation from April to December 2013 measuring the impact of our pathway on rates of new AC and other performance measures in patients with uncomplicated AFF solely managed by emergency physicians. A standardized chart review identified demographics, comorbidities, and ED treatments. The primary outcome was the rate of new AC. Secondary outcomes were ED length of stay (LOS), referrals to AFF clinic, ED revisit rates, and 30-day rates of return visits for congestive heart failure (CHF), stroke, major bleeding, and death.

Results: ED AFF patients totalling 301 (129 pre-pathway [PRE]; 172 post-pathway [POST]) were included; baseline demographics were similar between groups. The rates of AC at ED presentation were 18.6% (PRE) and 19.7% (POST). The rates of new AC on ED discharge were 48.6% PRE (95% confidence interval [CI] 42.1%-55.1%) and 70.2% POST (62.1%-78.3%) (20.6% [$p < 0.01$; 15.1-26.3]). Median ED LOS decreased from 262 to 218 minutes (44 minutes [$p < 0.03$; 36.2-51.8]). Thirty-day rates of ED revisits for CHF decreased from 13.2% to 2.3% (10.9%; $p < 0.01$; 8.1%-13.7%), and rates of other measures were similar.

Conclusions: The evidence-based pathway led to an improvement in the rate of patients with new AC upon discharge, a reduction in ED LOS, and decreased revisit rates for CHF.

RÉSUMÉ

Contexte: Un nouveau parcours de traitement de la fibrillation auriculaire et du flutter (FAF) au service des urgences (SU), fondé sur des données probantes a été élaboré afin d'améliorer la prestation de soins. L'étude avait pour objectif principal de mesurer le taux de nouvelle anticoagulation (AC) au moment du congé du SU chez des patients atteints de FAF mais non soumis à une anticoagulation appropriée au moment de la consultation.

Méthode: Il s'agit d'une étude d'évaluation de type avant-après, menée d'avril à décembre 2013, qui visait à mesurer l'incidence du parcours de traitement sur le taux de nouvelle AC et sur d'autres mesures de rendement chez des patients atteints de FAF sans complications et traités seulement par des médecins d'urgence. La collecte de données démographiques et de renseignements sur les maladies concomitantes et les traitements prescrits au SU a été réalisée à l'aide d'un examen uniformisé de dossiers. Le principal critère d'évaluation consistait en le taux de nouvelle AC. Les critères secondaires d'évaluations comprenaient la durée de séjour (DS) au SU, l'orientation vers un centre de traitement de la FA et du flutter, le taux de reconsultation au SU et le taux de reconsultation au bout de 30 jours pour de l'insuffisance cardiaque (ICC), un accident vasculaire cérébral, une hémorragie importante ou la mort.

Résultats: Au total, 301 patients atteints de FAF et traités au SU (129 avant le parcours et 172 après le parcours) ont été retenus dans l'étude; les données démographiques de base étaient comparables dans les deux groupes. Les taux d'AC au moment de la consultation au SU étaient de 18,6 % et de 19,7 % avant et après le parcours respectivement, et les taux de nouvelle AC au moment du congé du SU, de 48,6 % (IC à

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95 % : 42,1-55,1 %) et de 70,2 % (62,1-78,3 %) (20,6 % [$p < 0,01$: 15,1-26,3]) respectivement. La DS médiane au SU est passée de 262 minutes à 218 (44 minutes [$p < 0,03$: 36,2-51,8]) et le taux de reconsultation au SU au bout de 30 jours pour de l'ICC, de 13,2 % à 2,3 % (10,9 %; $p < 0,01$: 8,1-13,7 %). Le taux des autres mesures était similaire.

Conclusions: Le parcours de traitement fondé sur des données probantes s'est traduit par une amélioration du taux

de nouvelle AC au moment du congé, une réduction de la DS au SU et une diminution du taux de reconsultation pour de l'ICC.

Keywords: atrial fibrillation, atrial flutter, anticoagulation, emergency department

INTRODUCTION

Atrial fibrillation and flutter (AFF) are the most common arrhythmias presenting to the emergency department (ED) and are associated with significant morbidity and mortality.¹⁻³ Chronic atrial fibrillation increases stroke risk,^{4,6} and individuals with paroxysmal atrial fibrillation may have a similar prognosis.^{7,8} In the United States, over 60% of ED patients with primary AFF are admitted to the hospital,⁹ whereas 15% of Canadian patients are admitted.¹⁰ Given that many patients may have difficulty accessing their family physicians or consultants, emergency physicians (EPs) may play a crucial role in providing evidence-based care to optimize patient outcomes.¹⁰⁻¹³

Embolic stroke is a complication of AFF, and studies have shown that many ED patients arrive with inappropriate anticoagulation.^{14,15} Unfortunately, EPs miss many opportunities to initiate anticoagulation in at-risk patients at the time of their ED visit.^{14,15} This misapplication of clinical practice guidelines is troubling, and the reasons are unclear.

To improve patient care, a coordinated, evidence-based, ED-based AFF pathway was developed at our institution. The primary objective of this study was to measure rates of new appropriate anticoagulation on ED discharge for AFF patients who were previously not anticoagulated according to evidence-based guidelines. Secondary objectives included evaluation of additional patient- and system-specific outcomes, including length of stay (LOS), rates of congestive heart failure (CHF), major bleeding complications and stroke at 30 days, referrals to our institution's AFF clinic, and ED revisit rates.

METHODS

This pre-post program evaluation chart review was conducted at two university-affiliated urban sites. St. Paul's Hospital is a tertiary care, inner-city hospital with an annual census of 84,000 ED visits. Cardiac care is comprehensive and includes a 24-hour catheterization

laboratory, an electrophysiology service, and cardiac transplant capability. Mount St. Joseph's hospital is a community centre receiving 35,000 ED patients annually and a general internal medicine ward. The centres share an administrative database capturing patient arrival and discharge times and all orders, including investigations, results, treatments, and consultations since 1999. This is linked to a validated regional database to capture ED revisits and to provincial vital statistics to capture mortality.¹⁰ This study was approved by the Clinical Research Ethics Board for the University of British Columbia.

Intervention

A coordinated, evidence-based ED atrial fibrillation and atrial flutter pathway was developed by EPs (CD, EG) in collaboration with cardiologists (BH, ST) and pharmacists (JH) at our institution. Pathway content was finalized through consensus discussion between emergency medicine, cardiology, and pharmacy (CD, BH, ST, JH). The pathway consists of a care map, decision aids, medication orders, management suggestions, and electronic consultation or referral documents, all embedded into the computerized physician order entry and integrated electronic medical record program (Sunrise Clinical Manager version 4.0, Eclipsys Corporation, Atlanta, Georgia). This program includes access to clinical decision support scores (e.g., CHADS₂ and HASBLED) and decision aids (Appendix 1). Implementation was preceded by a 1-month period, including educational rounds and targeted emails. Emails included background, rationale, and education on key elements of the pathway and were sent to EPs during 1 month, and 1 week prior to pathway implementation, and weekly for 1 month following implementation.

Patient selection

Using the database, we identified consecutive patients presenting to the two study EDs with a final EP

diagnosis of atrial fibrillation (ICD10 code I48.0) or flutter (ICD10 code I48.1). Board-certified cardiologists verified each electrocardiogram (ECG) within 24 hours, and each patient required ECG confirmation of the diagnosis. The AFF pathway was activated at our institution on July 24, 2013. We included patients from April 30 until July 23, 2013 (pre-pathway implementation period [PRE]) and patients in the post-pathway group (POST) from August 25 until December 22, 2013. We allowed a 1-month education and implementation period for EPs to adopt the pathway (July 24 to August 24, 2013).

Exclusions

We enrolled uncomplicated AFF patients solely managed by EPs. The following patients were excluded: 1) those referred directly to cardiologists or internists in the ED because EPs would not manage anticoagulation; 2) those attending the ED only to monitor their anticoagulation; 3) those within 7 days of invasive cardiac procedures (pacemaker implantation, ablation procedures, coronary artery bypass grafting, or percutaneous coronary intervention) as management decisions are deferred to the surgeon or cardiologist; and 4) those with the following acute medical conditions: sepsis, shock, pneumonia, acute coronary syndrome, acute decompensated CHF, pulmonary embolism, chronic obstructive pulmonary disease (COPD), thyrotoxicosis, hypertensive emergency, drug overdose, acute valvular disease, or hypothermia. (See Appendix 2 for standardized definitions.)

Chart review

We adhered to the criteria for medical record review described by Kaji et al.¹⁶ Six senior medical student reviewers, blinded to study hypothesis and patient outcomes, and trained on the first 10 charts, independently abstracted charts onto standardized electronic spreadsheets to document triage scores, comorbidities, and ED treatments. Patients' electronic charts were scrutinized as far back as 1999 to clarify missing or unclear information; such controversial data were managed by external audit by the primary investigator (DB). A random sample of 20% of the data was double-collected by reviewers blinded to the initial data and checked by study investigators to ensure quality and completeness. Inter-rater reliability was assessed on a

random subset of 75 charts (24.9%) using the following variables: time to first ECG, cardioversion method, anticoagulation at ED arrival, and anticoagulation at ED discharge.

Data

AFF quality of care measures was determined from the Canadian Cardiovascular Society Guidelines for the management of AFF and consensus statements on quality of care in Canadian EDs¹⁷⁻¹⁹: rates of anticoagulation; other medication usage; ED cardioversion; ED LOS; and referral to outpatient atrial fibrillation were collected. (The hospitals share a referral clinic where patients are seen within 7-10 days by an electrophysiologist.) "New appropriate anticoagulation" was defined in this study as patients with atrial fibrillation or atrial flutter presenting to the ED who were not previously on antiplatelet or anticoagulant medications (refer to Appendix 1 for definitions of comorbidities and clinical scores [i.e., CHADS₂]) and discharged from the ED with a prescription for new antiplatelet (aspirin [ASA] only)¹⁹ or anticoagulant medications, depending on predefined prescribing thresholds for these medications (i.e., CHADS₂) and risk of bleeding (HASBLED score), previously defined by the Canadian Cardiovascular Society.¹⁹

Outcomes

The primary outcome is the proportion of AFF patients who were correctly started on new anticoagulant medications by the EP (based on CHADS₂ and HASBLED) in each of the two time periods. Secondary outcomes for this study included ED LOS, outpatient clinic referral, and 30-day rates of the following: ED revisit, re-hospitalization, CHF, ischemic or hemorrhagic stroke, major bleeding, and death. Additional secondary outcomes included age (>65 years) and gender-based differences in the rates of new anticoagulation. Prior work on this topic has described age and gender discrepancies in the rates of new anticoagulation.⁵

Sample size calculation

Sample size was calculated a priori based upon the primary outcome. Upon reviewing the literature,^{11,15} we anticipated our baseline rate of appropriate anticoagulation at discharge to be 34%. We determined a

15% change in the rates of new anticoagulation upon ED discharge as clinically significant through consensus discussion (RS, DH, DB), and an extensive review of prior work on this topic.^{15,20,21} To demonstrate a clinically important change of 15% in this proportion, with 80% power and an alpha of 0.05, we required 248 patients overall.

Statistical analysis

Proportions were compared using the chi-square test with 95% confidence intervals (CIs). Nonparametric data were compared using the Mann-Whitney U test with 95% CIs. Rates were described using proportions, medians, interquartile ranges (IQRs), and 95% CIs. We used Excel (version 14.4.8; Microsoft Corp., Redmond, Washington) and Stata (version 11; StataCorp, College Station, Texas) for all analyses.

RESULTS

The AFF pathway was activated at our institution on July 24, 2013. We included 129 patients from April 30 until July 23, 2013 (PRE) and 172 patients in POST from August 25 until December 22, 2013, for a total of 301 (Figure 1). The inter-rater agreement for data collection was $k = 0.81$.

Baseline demographics of both groups were similar in terms of age, sex distribution, triage score, arrhythmia distribution, and comorbidities, evidenced by the similar CHADS₂ and HASBLED scores. The rates of appropriate anticoagulation at ED presentation were 18.6% (PRE) and 19.7% (POST). Regarding ED management, there was a similar proportion of patients who were rate and rhythm controlled; consultation rates were likewise similar (Table 1).

The rates of new anticoagulation on discharge from the ED, for patients who were incorrectly not on anticoagulation at ED arrival, were 51 / 105 (48.6%, 95% CI 42.1% to 55.1%) in the PRE group and 97 / 138 (70.2%, 95% CI 62.1% to 78.3%) in the POST group, for an absolute difference of 20.6% (95% CI 15.1% to 26.3%). The median age of patients receiving new anticoagulation was 61 years (PRE) and 65 years (POST), which were not significantly different.

Post-hoc analysis revealed that, in the pre-group, 10 / 53 women (18.6%) were on anticoagulation, comparable to the male rate. Of the 43 eligible women, none

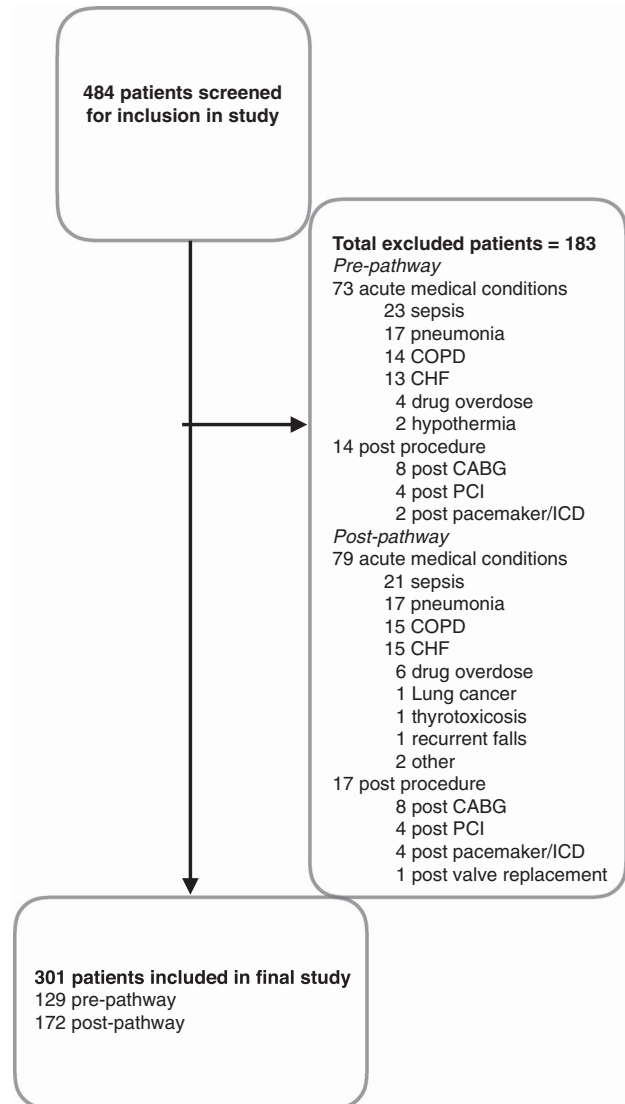


Figure 1. Patient flow within study

were started on anticoagulation, as compared to 69.7% in the male group. In the post-group, 22 / 56 eligible women (39.2%) (difference 39.2% [95% CI 25.1%-53.3%]) were started on anticoagulation, as compared to 75 / 102 eligible males.

The overall ED LOS for the departments did not change during the study periods (personal communication, D. Kalla). Median (IQR) ED LOS for patients with AFF was 262 minutes (162 to 431) in the pre-group and 218 minutes (152 to 375) in the post-group, for a difference of 44.0 minutes ($p < 0.03$; 95% CI 36.2 minutes to 51.8 minutes) (Table 2). The rate of atrial fibrillation clinic referrals increased from 22 / 129 (17.1%) to 45 / 172 (26.2%) (difference 9.1%, 95% CI

Table 1. Descriptive characteristics of study population		
Descriptive variable	Pre-pathway (n = 129)	Post-pathway (n = 172)
Age (95% CI)	66.0 (63.8-68.3) Median 66	65.0 (63.0-67.0) Median 65
Gender (% male)	59.2%	59.3%
CTAS score *absolute (%)		
CTAS 1	0	0
CTAS 2	70 (54.3%)	115 (66.9%)
CTAS 3	50 (38.8%)	45 (26.2%)
CTAS 4	5 (3.9%)	4 (2.3%)
CTAS 5	0	0
Data missing	4 (3.1%)	8 (4.7%)
Patients appropriately on anticoagulation at ED arrival (%)	24 (18.6%)	34 (19.7%)
Warfarin	10 (7.7%)	12 (6.9%)
Dabigatran	6 (4.7%)	7 (4.2%)
Rivaroxaban	3 (2.3%)	3 (1.7%)
Apixaban	1 (0.8%)	0
Aspirin	4 (3.1%)	12 (6.9%)
Minutes to first ECG (95% CI)	0:20 (19.5-20.5) Median 0:15	0:19 (18.8-19.2) Median 0:14
Presenting rhythm (%) [95% CI]		
Atrial fibrillation	85 (65.9%) [58.0-74.3]	108 (62.8%) [53.8-68.1]
Atrial flutter	38 (29.5%) [21.4-37.0]	31 (18.0%) [11.9-23.1]
Other [†]	6 (4.6%) [1.0-8.2]	33 (19.2%) [10.3-20.4]
Cardioversion method (%) [95% CI]		
Chemical	40 (31.0%) [23.5-39.5]	52 (30.2%) [22.7-36.1]
Electrical	25 (19.4%) [12.4-25.9]	33 (19.2%) [12.9-24.3]
No cardioversion	64 (49.6%) [40.7-57.9]	87 (50.6%) [44.6-59.4]
Mean CHADS ₂ Score (95% CI)	2.1 (1.8-2.4)	1.9 (1.7-2.1)
Patients with CHADS ₂ Score 0	27	39
Patients with CHADS ₂ Score 1	20	34
Patients with CHADS ₂ Score 2	28	35
Patients with CHADS ₂ Score 3	24	21
Patients with CHADS ₂ Score 4	14	16
Patients with CHADS ₂ Score 5	6	11
Patients with CHADS ₂ Score 6	5	3
<i>Patients with missing data</i>	5	13
Mean HASBLED Score (95% CI)	1.5 (1.3-1.7)	1.2 (1.0-1.4)
Patients with HASBLED Score 0	22	40
Patients with HASBLED Score 1	50	66
Patients with HASBLED Score 2	29	34
Patients with HASBLED Score 3	20	13
Patients with HASBLED Score 4	2	4
Patients with HASBLED Score 5	1	0
Patients with HASBLED Score 6	0	0
<i>Patients with missing data</i>	5	15

CI = confidence interval; ECG = electrocardiogram; ED = emergency department.
 *Canadian Triage and Acuity Scale.
[†]Atrial fibrillation or flutter with aberrancy, left bundle morphology or pacemaker.

Table 2. ED AFF performance measures and outcomes

ED AFF performance measure	Pre-pathway (n = 129)	Post-pathway (n = 172)	Difference
Patients on appropriate anticoagulant medication at ED arrival (% of total)	24 (18.6%)	34 (19.7%)	+1.1% (- 0.1 to + 1.2%)
Discharged from ED on new AC* by EP (% of eligible patients)	51 (48.6%)	97 (70.2%)	+20.6% [†] (95% CI [15.1%-26.3%])
Median ED length of stay (minutes)	262 (IQR 166-431)	218 (IQR 152-375)	44 [‡] (95% CI [36.2-51.8])
ED return with atrial fibrillation or flutter [§]	18 (14.0%)	23 (13.4%)	- 0.6% (95% CI [+ 0.3 to - 1.5%])
ED return with congestive heart failure [§]	17 (13.2%)	4 (2.3%)	- 10.9% [†] (95% CI [- 8.1 to - 3.7%])
ED return with major bleeding [§]	1 (0.8%)	1 (0.6%)	- 0.2% (95% CI [+ 0.3 to - 0.7%])
ED return with stroke (ischemic or hemorrhagic) [§]	0	0	0
Mortality [§]	1 (0.8%)	0	- 0.8% (95% CI [+ 0.2 to - 1.8%])

AFF = atrial fibrillation and flutter; CI = confidence interval; ED = emergency department; IQR = interquartile range.
 *Appropriate anticoagulant or antithrombotic medication.
[†]*p* < 0.01.
[‡]*p* < 0.03.
[§]Within 30 days of index ED visit.

Table 3. Anticoagulant and antiplatelet medications used by study population

	Pre-pathway (n = 129)	Post-pathway (n = 172)
New AC medications prescribed at discharge	51 (48.6%)	97 (70.2%)
Warfarin	9 (17.6%)	11 (11.3%)
Dabigatran	1 (2.0%)	3 (3.1%)
Rivaroxaban	1 (2.0%)	10 (10.3%)
ASA	9 (17.6%)	23 (23.7%)
Specific medication data missing	30 (58.8%)	50 (51.5%)

AC = anticoagulation; ASA = aspirin.

5.85% to 12.35%). The new anticoagulation medications prescribed to patients by EPs in the PRE and POST study groups were similar (Table 3).

The 30-day ED revisit rate for CHF decreased from 13.2% (PRE) to 2.3% (POST) (absolute difference of 10.9%; *p* < 0.01 (95% CI -8.1% to -13.7%). Thirty-day ED revisits for AFF, major bleeding episodes, and mortality were similar for the two groups. There were no strokes in either group. One study patient died: an 84-year-old male in the pre-group, with Stage IV liver cancer and long-standing atrial fibrillation. After discussion with his family, he was discharged home in stable condition and died at 28 days.

DISCUSSION

In this two-centre study of 301 patients with uncomplicated atrial fibrillation or flutter who were solely managed by EPs, the introduction of a standardized, evidence-based pathway dramatically improved rates of appropriate anticoagulation from 48.6% to 70.2%. In addition, without changes in the overall ED LOS at the two participating centres during the study period, the median ED LOS for patients with AFF decreased by 44 minutes. Furthermore, the 30-day ED revisit rate for CHF decreased from 13.2% to 2.3% following the implementation of our pathway. Importantly, rates of ED revisits for AFF, major bleeding, and mortality remained similarly low, there were no strokes in either group, and clinic follow-up rates improved. This assists clinicians by highlighting the benefits of a coordinated, evidence-based ED AFF pathway on improving care and potentially decreasing resource use.

Although new anticoagulation is a key quality of care indicator for patients with AFF by expert consensus statements and clinical practice guidelines,¹⁷⁻¹⁹ little work has been done on improving low ED anticoagulation rates. Given that less than one-fifth of patients were admitted, EPs were the key prescribers of appropriate antithrombotic (ASA) and anticoagulant medications for the majority of patients not already on

these medications. It is discouraging that the majority of ED AFF patients are not correctly started on anticoagulation while in the community, and the reasons for this are likewise unclear. In 2014, almost 15% of Canadians lacked a family physician,²² and many patients who do possess a family physician have difficulty accessing them, or specialist consultants, in a timely fashion.^{23,24} Given this lack of follow-up care for some patients,²² or potentially dangerous delays for others,^{23,24} it is imperative that EPs provide optimal, evidence-based care in the ED. The prescribing of new anticoagulation is a key quality of care metric,¹⁷⁻¹⁹ and a recent multicentre Canadian study has shown that almost half of ED patients with AFF are discharged without appropriate anticoagulation.²⁵ Our study demonstrates that EPs can strive to optimize patient outcomes with evidence-based prescribing and care in the ED.

An important feature of our study is that we have identified two vulnerable patient groups for whom new anticoagulation at ED discharge is suboptimal. No women received new anticoagulation upon ED discharge prior to pathway implementation; after pathway implementation, the rate improved to 39.2%. (In comparison, after pathway implementation, 73.5% of eligible men were discharged with new anticoagulation from the EP.) Although the rates of appropriate anticoagulation for women are still dismal, and the reasons behind this are unknown, we believe that our pathway at least provides some improvement. In addition, our study suggests that older patients received lower rates of new anticoagulation upon ED discharge prior to pathway implementation. Our findings are similar to prior work that demonstrates gender and age-based differences in the anticoagulation of AFF patients, both in the ED²⁵ and primary care settings.^{26,27,28} The discrepancies in our study were partially improved by our coordinated evidence-based intervention and further highlight its importance to optimize patient care and outcomes, although there is still room for improvement.

Prior ED-based AFF pathways have separately focused on control of rate or rhythm, LOS, and patient satisfaction. Decker et al. described an observation unit that reduced median LOS to 10.1 hours but did not report on anticoagulation²⁹; our LOS of 3.6 hours may compare favourably. Elmouchi et al. demonstrated that ED-based AFF pathways improve patient satisfaction and quality of life but did not measure new

anticoagulation or ED LOS.³⁰ Although our study did not directly measure patient-centred AFF outcomes, a key finding of our study is that the 30-day ED revisit rate for CHF dropped from 13.2% to 2.3% following pathway implementation. It is unclear whether pathway implementation improved ED management of patients with AFF, or whether its presence resulted in the use of specific cognitive forcing strategies by EPs.³¹ It is conceivable that patients would identify not having to return to the ED within 30 days of a sentinel visit for AFF as an important measure of quality of care. Further, despite our substantially decreased LOS, we did not observe increased rates of 30-day mortality or return to the ED within 30 days for AFF or serious complications thereof. This suggests that the development of a coordinated, evidence-based ED AFF pathway may not adversely affect patient outcomes and key performance metrics. However, prospective external validation of our findings is warranted.

LIMITATIONS

This study took place in two urban Canadian EDs with an AFF admission rate of approximately 20%, and it may be difficult to generalize to other settings.^{9,32-36} The lack of control sites means that the potential influence of outside influences upon these two centres is hard to determine. Importantly, this retrospective pre-post design is subject to lack of randomization and regression to the mean.³⁷ Although the study size is sufficient to estimate pathway effectiveness, the numbers may be too small to evaluate serious downstream adverse events. The ascertainment of individual comorbidities carries with it the potential for misclassification bias; this could affect each of the risk stratification scores, although the direction of bias would be unknown.

Our inclusion of 5 months of ED patients in our study to measure pathway outcomes ensures that we were unable to examine seasonal or secular trends, or regression to the statistical mean. We are also unable to comment on the sustainability of this intervention or extrapolation to other centres. We did not describe long-term follow-up, and it is unclear whether patients were adherent to EP recommendations and prescriptions.³⁸ Furthermore, it is possible that such advice was either augmented or countermanded by a subsequent community physician. We did not assess either patient or provider preferences or satisfaction or the costs

associated with our pathway. Finally, patients who had an out-of-region ED hospital admission or out-of-province death would not have been captured.

CONCLUSION

In conclusion, the implementation of an evidence-based, coordinated ED AFF pathway led to a significant improvement in the rate of patients with new appropriate anticoagulation upon discharge from the ED. A significant reduction in the mean ED LOS and ED revisit rates for CHF were observed, with no increase in patient mortality or key ED return rates.

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Competing interests: None declared.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit <https://doi.org/10.1017/cem.2017.418>

REFERENCES

1. Feinberg WM, Blackshear JL, Laupacis A, et al. Prevalence, age distribution, and gender of patients with atrial fibrillation. Analysis and implications. *Arch Intern Med* 1995; 155(5):469-73.
2. Valderrama AL, Dunbar SB, Mensah GA. Atrial fibrillation: public health implications. *Am J Prev Med* 2005;29 (5 Suppl 1):75-80; doi:10.1016/j.amepre.2005.07.021.
3. Wolf PA, Abbott RD, Kannel WB. Atrial fibrillation: a major contributor to stroke in the elderly. The Framingham Study. *Arch Intern Med* 1987;147(9):1561-4.
4. Lakshminarayan K, Anderson DC, Herzog CA, et al. Clinical epidemiology of atrial fibrillation and related cerebrovascular events in the United States. *Neurologist* 2008; 14(3):143-50; doi:10.1097/NRL.0b013e31815cfae.
5. Béjot Y, Ben Salem D, Osseby GV, et al. Epidemiology of ischemic stroke from atrial fibrillation in Dijon, France, from 1985 to 2006. *Neurology* 2009;72(4):346-53; doi:10.1212/01.wnl.0000341280.31919.bd.
6. Albers GW, Atwood JE, Hirsh J, et al. Stroke prevention in nonvalvular atrial fibrillation. *Ann Intern Med* 1991; 115(9):727-36.
7. Hohnloser SH, Pajitnev D, Pogue J, et al. Incidence of stroke in paroxysmal versus sustained atrial fibrillation in patients taking oral anticoagulation or combined antiplatelet therapy: an ACTIVE W substudy. *J Am Coll Cardiol* 2007; 50(22):2156-61; doi:10.1016/j.jacc.2007.07.076.
8. Nieuwlaat R, Dinh T, Olsson SB, et al. Should we abandon the common practice of withholding oral anticoagulation in paroxysmal atrial fibrillation? *Eur Heart J* 2008; 29(7):915-22; doi:10.1093/eurheartj/ehn101.
9. McDonald AJ, Pelletier AJ, Ellinor PT, et al. Increasing US emergency department visit rates and subsequent hospital admissions for atrial fibrillation from 1993 to 2004. *Ann Emerg Med* 2008;51(1):58-65; doi:10.1016/j.annemergmed.2007.03.007.
10. Scheuermeyer FX, Grafstein E, Stenstrom R, et al. Thirty-day outcomes of emergency department patients undergoing electrical cardioversion for atrial fibrillation or flutter. *Acad Emerg Med* 2010;17(4):408-15; doi:10.1111/j.1553-2712.2010.00697.x.
11. Scheuermeyer FX, Grafstein E, Heilbron B, et al. Emergency department management and 1-year outcomes of patients with atrial flutter. *Ann Emerg Med* 2011;57(6): 564-71.e2; doi:10.1016/j.annemergmed.2010.09.027.
12. Scheuermeyer FX, Innes G, Grafstein E, et al. Safety and efficiency of a chest pain diagnostic algorithm with selective outpatient stress testing for emergency department patients with potential ischemic chest pain. *Ann Emerg Med* 2012; 59(4):256-64; doi:10.1016/j.annemergmed.2011.10.016.
13. Michael JA, Stiell IG, Agarwal S, et al. Cardioversion of paroxysmal atrial fibrillation in the emergency department. *Ann Emerg Med* 1999;33(4):379-87.
14. Misra P, Lang E, Clement CM, et al. Emergency physician patterns related to anticoagulation of patients with recent-onset atrial fibrillation and flutter. *J Atr Fibrillation* 2013;5(6):645.
15. Scheuermeyer FX, Innes G, Pourvali R, et al. Missed opportunities for appropriate anticoagulation among emergency department patients with uncomplicated atrial fibrillation or flutter. *Ann Emerg Med* 2013;62(6):557-65.e2; doi:10.1016/j.annemergmed.2013.04.004.
16. Kaji AH, Schriger D, Green S. Looking through the retrospectroscope: reducing bias in emergency medicine chart review studies. *Ann Emerg Med* 2014;64(3):292-8; doi:10.1016/j.annemergmed.2014.03.025.
17. Schull MJ, Guttman A, Leaver CA, et al. Prioritizing performance measurement for emergency department care: consensus on evidence-based quality of care indicators. *CJEM* 2011;13(5):300-9, E28-43.
18. European Heart Rhythm Association, Heart Rhythm Society, Fuster V, et al. ACC/AHA/ESC 2006 guidelines for the management of patients with atrial fibrillation – executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to revise the 2001 guidelines for the management of patients

- with atrial fibrillation). *J Am Coll Cardiol* 2006;48(4):854-906; doi:[10.1016/j.jacc.2006.07.009](https://doi.org/10.1016/j.jacc.2006.07.009).
19. Skanes AC, Healey JS, Cairns JA, et al. Focused 2012 update of the Canadian Cardiovascular Society atrial fibrillation guidelines: recommendations for stroke prevention and rate/rhythm control. *Can J Cardiol* 2012;28(2):125-36; doi:[10.1016/j.cjca.2012.01.021](https://doi.org/10.1016/j.cjca.2012.01.021).
 20. Scheuermeyer FX, Mackay M, Christenson J, et al. There are sex differences in the demographics and risk profiles of emergency department (ED) patients with atrial fibrillation and flutter, but no apparent differences in ED management or outcomes. *Acad Emerg Med* 2015;22(9):1067-75.
 21. Buckingham TA, Hatala R. Anticoagulants for atrial fibrillation: why is the treatment rate so low? *Clin Cardiol* 2002;25(10):447-54.
 22. Statistics Canada. 82-625-X. Access to a regular medical doctor; 2014. Available at: <http://www.statcan.gc.ca/pub/82-625-x/2015001/article/14177-eng.htm> (accessed 3 July 2017).
 23. Barua B, Ren F. Fraser Institute. Waiting your turn: wait times for health care in Canada, 2016 report; 2016. Available at: <http://www.fraserinstitute.org>.
 24. Canadian Institute for Health Information. *Health care in Canada, 2012: a focus on wait times*. Ottawa, ON: CIHI; 2012.
 25. Stiell IG, Clement CM, Rowe BH, et al. Outcomes for emergency department patients with recent-onset atrial fibrillation and flutter treated in Canadian hospitals. *Ann Emerg Med* 2017;69(5):562-71.e2; doi:[10.1016/j.annemergmed.2016.10.013](https://doi.org/10.1016/j.annemergmed.2016.10.013).
 26. Coll-Vinent B, Martín A, Malagón F, et al. Stroke prophylaxis in atrial fibrillation: searching for management improvement opportunities in the emergency department: the HERMES-AF study. *Ann Emerg Med* 2015;65(1):1-12.
 27. Mashal A, Katz A, Shvartzman P. Atrial fibrillation: a primary care cross-sectional study. *Isr Med Assoc J* 2011;13(11):666-71.
 28. Stafford RS, Singer DE. National patterns of warfarin use in atrial fibrillation. *Arch Intern Med* 1996;156(22):2537-41; doi:[10.1001/archinte.1996.00440210043004](https://doi.org/10.1001/archinte.1996.00440210043004).
 29. Decker WW, Smars PA, Vaidyanathan L, et al. A prospective, randomized trial of an emergency department observation unit for acute onset atrial fibrillation. *Ann Emerg Med* 2008;52(4):322-8; doi:[10.1016/j.annemergmed.2007.12.015](https://doi.org/10.1016/j.annemergmed.2007.12.015).
 30. Elmouchi DA, VanOosterhout S, Muthusamy P, et al. Impact of an emergency department-initiated clinical protocol for the evaluation and treatment of atrial fibrillation. *Crit Pathw Cardiol* 2014;13(2):43-8; doi:[10.1097/HPC.0000000000000008](https://doi.org/10.1097/HPC.0000000000000008).
 31. Croskerry P. Cognitive forcing strategies in clinical decision making. *Ann Emerg Med* 2003;41(1):110-20.
 32. Cristoni L, Tampieri A, Mucci F, et al. Cardioversion of acute atrial fibrillation in the short observation unit: comparison of a protocol focused on electrical cardioversion with simple antiarrhythmic treatment. *Emerg Med J* 2011;28(11):932-7.
 33. Farmakis D, Pipilis A, Antoniou A, et al. Clinical profile and therapeutic management of patients with atrial fibrillation in Greece: results from the Registry of Atrial Fibrillation to Investigate New Guidelines (RAFTING). *Hellenic J Cardiol* 2013;54(5):368-75.
 34. Domanovits H, Schillinger M, Thoennissen J, et al. Termination of recent-onset atrial fibrillation/flutter in the emergency department: a sequential approach with intravenous ibutilide and external electrical cardioversion. *Resuscitation* 2000;45(3):181-7.
 35. Taylor DM, Aggarwal A, Carter M, et al. Management of new onset atrial fibrillation in previously well patients less than 60 years of age. *Emerg Med Australas* 2005;17(1):4-10.
 36. Dankner R, Shahar A, Novikov I, et al. Treatment of stable atrial fibrillation in the emergency department: a population-based comparison of electrical direct-current versus pharmacological cardioversion or conservative management. *Cardiology* 2009;112(4):270-8.
 37. Harris AD, Bradham DD, Baumgarten M, et al. The use and interpretation of quasi-experimental studies in infectious diseases. *Clin Infect Dis* 2004;38(11):1586-91; doi:[10.1086/420936](https://doi.org/10.1086/420936).
 38. Atzema CL, Austin PC, Chong AS, et al. The long-term use of warfarin among atrial fibrillation patients discharged from an emergency department with a warfarin prescription. *Ann Emerg Med* 2015;66(4):347-54.e2.