EM Advances

Association of the Ottawa Aggressive Protocol with rapid discharge of emergency department patients with recent-onset atrial fibrillation or flutter

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ABSTRACT

Objective: There is no consensus on the optimal management of recent-onset episodes of atrial fibrillation or flutter. The approach to these conditions is particularly relevant in the current era of emergency department (ED) overcrowding. We sought to examine the effectiveness and safety of the Ottawa Aggressive Protocol to perform rapid cardioversion and discharge patients with these arrhythmias.

Methods: This cohort study enrolled consecutive patient visits to an adult university hospital ED for recent-onset atrial fibrillation or flutter managed with the Ottawa Aggressive Protocol. The protocol includes intravenous chemical cardioversion, electrical cardioversion if necessary and discharge home from the ED.

Results: A total of 660 patient visits were included, 95.2% involving atrial fibrillation and 4.9% involving atrial flutter. The mean age of patients enrolled was 64.5 years. In total, 96.8% were discharged home and, of those, 93.3% were in sinus rhythm. All patients were initially administered intravenous procainamide, with a 58.3% conversion rate. A total of 243 patients underwent subsequent electrical cardioversion with a 91.7% success rate. Adverse events occurred in 7.6% of cases: hypotension 6.7%, bradycardia 0.3% and 7-day relapse 8.6%. There were no cases of torsades de pointes, stroke or death. The median lengths of stay in the ED were as follows: 4.9 hours overall, 3.9 hours for those undergoing conversion with procainamide and 6.5 hours for those requiring electrical conversion.

Conclusion: This is the largest study to date to evaluate the Ottawa Aggressive Protocol, a unique approach to cardioversion for ED patients with recent-onset episodes of atrial fibrillation and flutter. Our data demonstrate that the Ottawa Aggressive Protocol is effective, safe and rapid, and has the potential to significantly reduce hospital admissions and expedite ED care.

Keywords: atrial fibrillation, atrial flutter, emergency department, cardioversion, electrical cardioversion, arrhythmias

RÉSUMÉ

Objectif : Aucun consensus n'a été dégagé à ce jour sur la prise en charge optimale d'épisodes récents de fibrillation ou de flutter auriculaire. La prise en charge de ces troubles du rythme cardiaque est particulièrement pertinente dans le contexte actuel d'engorgement dans les urgences. Nous avons cherché à examiner l'efficacité et la sécurité du Protocole de prise en charge énergique d'Ottawa (Protocole d'Ottawa) pour réaliser rapidement une cardioversion chez les patients présentant ces arythmies et leur donner leur congé.

Méthodes : Dans cette étude de cohorte, nous avons inscrit tous les patients adultes vus consécutivement pour un récent épisode de fibrillation ou de flutter auriculaire et pris en charge selon le Protocole d'Ottawa à l'urgence d'un hôpital universitaire. Ce Protocole comprend une cardioversion chimique par voie intraveineuse; la cardioversion électrique, le cas échéant; le congé de l'urgence.

Résultats : L'étude portait sur 660 patients, dont 95,2 % présentaient une fibrillation auriculaire et 4,9 %, un flutter auriculaire. L'âge moyen des patients était de 64,5 ans; 96,8 % ont regagné leur domicile et, de ce nombre, 93,3 % ont eu une conversion en rythme sinusal. On a d'abord administré à tous les patients de la procaïnamide par voie intraveineuse. Le taux de conversion était de 58,3 %. Par la suite, 243 patients ont subi une cardioversion électrique, avec un taux de

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réussite de 91,7 %. Des événements indésirables sont survenus dans 7,6 % des cas : hypotension, 6,7 %; bradycardie, 0,3 %; rechute après 7 jours, 8,6 %. Il n'y a eu aucun cas de torsades de pointes, d'accident vasculaire cérébral ou de mortalité. La durée médiane du séjour à l'urgence était de 4,9 heures globalement; de 3,9 heures chez ceux qui se sont convertis en rythme sinusal avec de la procaïnamide; et de 6,5 heures chez ceux qui ont été soumis à une cardioversion électrique.

Conclusion : Il s'agit de la plus importante étude d'évaluation du Protocole de prise en charge énergique d'Ottawa réalisée à ce jour, une approche unique à la cardioversion chez les patients à l'urgence présentant des épisodes récents de fibrillation et de flutter auriculaire. Nos données montrent que ce Protocole d'Ottawa est efficace, sûr et rapide et qu'il a le potentiel de réduire significativement les hospitalisations et d'accélérer les soins à l'urgence.

INTRODUCTION

Emergency physicians often care for patients with either recent-onset or chronic (permanent) atrial fibrillation. Typically in permanent atrial fibrillation, previous cardioversion attempts have failed or clinical judgment has led to a decision not to attempt cardioversion, and the focus of emergency department (ED) care is rate control and treatment of underlying conditions.[1] Recent-onset atrial fibrillation, made up of both first detected and recurrent episodes, is one of the most common arrhythmias seen in the ED and the management of such cases is more complex and controversial.[2,3] Atrial flutter is much less common than atrial fibrillation and often requires urgent electrical cardioversion.

There is no universally accepted approach for the ED management of recent-onset atrial fibrillation or flutter.[4–7] Considerable controversy exists surrounding 2 competing strategies, one conservative and the other aggressive. Conservative treatment consists of rate control, anticoagulation with warfarin and possible delayed cardioversion. With aggressive treatment, efforts are made to cardiovert appropriate patients to sinus rhythm in the ED, either pharmacologically or electrically.[8–10] Overcrowding in the ED is another complex issue that has emerged as a health care crisis over the past decade in most large, urban and academic North American EDs.[11–13] The cause of overcrowding is multifactorial, but prolonged ED lengths of stay and lack of hospital beds are important factors.[14–17] A recent study described admission to hospital as routine care in the United States for recent-onset atrial fibrillation and reported a mean length of stay longer than 48 hours and that 73% of patients underwent conversion to normal sinus rhythm before discharge.[18] This study evaluated a more rapid ED observation unit strategy and found that it was associated with an ED mean length of stay of 12 hours and a conversion rate of 85%. At our institution, the Ottawa Hospital, emergency physicians have long followed a practice of acute rhythm control and rapid discharge home for recent-onset atrial fibrillation and flutter.[3] To our knowledge, no other centre has described the approach that we have termed the "Ottawa Aggressive Protocol." This approach involves sequential pharmacologic and, when indicated, electrical cardioversion by the emergency physician with a goal of avoiding prolonged ED length of stay, hospital admission or repeat visits.

The objective of this study was to examine the efficacy and safety of the Ottawa Aggressive Protocol for patients with recent-onset episodes of atrial fibrillation and flutter. Specifically, we wished to evaluate the outcomes of this strategy with regard to conversion to normal sinus rhythm, adverse events, hospital admission, ED length of stay and relapse.

METHODS

Study design

This medical record review included eligible cases seen at the Ottawa Hospital Civic Campus ED from Jan. 1, 2000, to Jun. 30, 2005, inclusive.

Setting

The Ottawa Hospital is an adult, tertiary care institution affiliated with the University of Ottawa, and the Civic Campus has an annual ED census of 60 000 visits.

Population

We enrolled a consecutive cohort of ED patient visits with a primary diagnosis of a recent-onset episode of atrial fibrillation or atrial flutter and where an aggressive attempt at cardioversion was used. Some patients presented more than once, and all such visits that were more than 7 days apart were included as discrete encounters. We excluded patients with permanent atrial fibrillation (chronic, persistent or longstanding), patients with symptoms for greater than 48 hours or for an unknown duration (unless they were therapeutically anticoagulated with warfarin)[5] and patients with another

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primary diagnosis necessitating admission (e.g., cardiac ischemia or congestive heart failure). We did not exclude patients whose treatment for atrial fibrillation in the ED resulted in a complication necessitating admission. The Ottawa Hospital Research Ethics Board approved the protocol without the need for informed consent.

Clinical protocol

The treatment of all included patients was managed by emergency physicians using the Ottawa Aggressive Protocol (Box 1), which is considered "routine care" for patients with recent-onset atrial fibrillation at our institution. This protocol involves a number of steps, which are elaborated on below.

1. Assessment: Assessment focuses on the stability of the patient, previous episodes and duration since onset. The decision of whether cardioversion is appropriate is made by the emergency physician involved and is usually based on the clarity of the history of arrhythmia onset. There is no upper age limit for the application of aggressive rhythm control. Every effort is made to ensure that the time from symptom onset is less than 48 hours and if this cannot be verified then rhythm control is not pursued unless the patient is on warfarin and has had a therapeutic international normalized ratio (INR) level for at least 3 weeks. If the time from symptom onset is longer than 48 hours or of uncertain duration, then transesophageal echocardiography can be pursued to determine the safety of cardioversion.[19] Patients are not routinely screened for elevation of troponin unless there is chest pain or ST and T wave changes.
2. Rate control: Rate control is often omitted as there is no compelling evidence that its use facilitates cardioversion. Physicians who choose to control heart rate before attempting cardioversion typically use intravenous diltiazem or metoprolol.
3. Pharmacologic cardioversion: Typically, emergency physicians at our institution attempt pharmacologic cardioversion before electrical cardioversion. Intravenous procainamide is the drug of choice in Ottawa for rhythm control, and we have previously described its use in detail.[20] Pharmacologic cardioversion is generally not attempted if the patient is deemed to be unstable (cardiac ischemia, severe congestive heart failure or hypotension) or if records indicate resistance to this approach on previous visits. The standard protocol is 1 g of procainamide in

Box 1. Details of the Ottawa Aggressive Protocol for emergency department patients with recent-onset atrial fibrillation

1. **Assessment**
   - Stable without ischemia, hypotension or acute CHF?
   - Onset clear and less than 48 hours?
   - Severity of symptoms?
   - Previous episodes and treatments?
   - Anticoagulated with warfarin and INR therapeutic?
2. **Rate control**
   - If highly symptomatic or not planning to convert
   - Diltiazem IV (0.25 mg/kg over 10 min; repeat at 0.35 mg/kg)
   - Metoprolol IV (5 mg doses every 15 min)
3. **Pharmacologic cardioversion**
   - Procainamide IV (1 g IV over 60 min; hold if blood pressure < 100 mm Hg)
4. **Electrical cardioversion**
   - Consider keeping patient NPO × 6 h
   - Procedural sedation and analgesia given by emergency physician (propofol IV and fentanyl IV)
   - Start at 150–200 J biphasic synchronized*
   - Use anterior–posterior pads, especially if not responding
5. **Anticoagulation**
   - Usually no heparin or warfarin for most patients if onset clearly < 48 h or if therapeutic INR for > 3 wk
6. **Disposition**
   - Home within 1 h after cardioversion
   - Usually no antiarrhythmic prophylaxis or anticoagulation given
   - Arrange outpatient echocardiography if first episode
   - Cardiology follow-up if first episode or frequent episodes
7. **Patients not treated with cardioversion**
   - Achieve rate control with diltiazem IV (target heart rate < 100 beats/min)
   - Discharge home on diltiazem (or metoprolol)
   - Discharge home on warfarin and arrange INR monitoring
   - Arrange outpatient echocardiography
   - Follow-up with cardiology at 4 wk for elective cardioversion
8. **Recommended additions to protocol**
   - Consider transesophageal echocardiography if onset unclear
   - Alternate rhythm-control drugs: propafenone, vernakalant, amiodarone
   - If TEE-guided cardioversion > 48 h, start warfarin
   - If $CHADS_2$ score ≥ 1, consider warfarin and arrange early follow-up

CHF = congestive heart failure; INR = international normalized ratio; IV = intravenously; NPO = nil per os (nothing by mouth); TEE = transesophageal echocardiography.
*Most patients treated with electrical cardioversion in the current study were managed with monophasic cardioversion.

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250 mL of dextrose and water as a controlled infusion over 1 hour, under continuous cardiac and blood pressure monitoring. The infusion is interrupted if blood pressure falls below 100 mm Hg; if a bolus of 250 mL of normal saline corrects the hypotension, the infusion is resumed.

4. Electrical cardioversion: If chemical cardioversion fails, most patients then undergo electrical cardioversion in the ED, supervised by the emergency physician. Typically, procedural sedation and analgesia using fentanyl and propofol is administered and biphasic waveform energy levels of 150–200 J are delivered (during the study period most patients received monophasic waveform defibrillation as biphasic defibrillation was not yet widespread).
5. Anticoagulation: Patients with a time from symptom onset that is clearly less than 48 hours or with therapeutic INR levels typically do not receive anticoagulation in the ED. Although controversial, current recommendations advise warfarin be administered for patients with transesophageal echocardiogram–guided cardioversion or with a $CHADS_2$ score of 1 or greater (Table 1).[5,19,21,22] The role of heparin is unclear and is rarely used for any patients at our institution.
6. Disposition: Patients who undergo successful cardioversion are typically discharged home within an hour without medication (that is, no new oral anticoagulants, rate control agents or rhythm control agents are prescribed or given). For first-time episodes, outpatient echocardiography and cardiology follow-up is usually recommended. Monitoring of the INR and appropriate physician follow-up is arranged for the few patients started on warfarin.
7. Patients not treated with cardioversion: Patients who are not treated with cardioversion in the ED have their rate controlled and are then discharged on oral anticoagulants and rate control medication. Monitoring of the INR and physician follow-up is also arranged for this group. Heparin is rarely given to these patients in our ED.

Table 1. $CHADS_2$ risk criteria for stroke in patients with nonvalvular atrial fibrillation if not treated with anticoagulation[21,22]

Risk criteria	Points
Prior stroke or TIA	2
Age > 75 yr	1
Hypertension	1
Diabetes mellitus	1
Congestive heart failure	1

TIA = transient ischemic attack.

Data collection

Patients were identified from the Ottawa Hospital health records database, which uses the Canadian National Ambulatory Care Reporting System (NACRS). Identification was based on the main diagnosis of atrial fibrillation or atrial flutter, combined with a procedure code of antiarrhythmic intravenous therapy or electrical cardioversion. Two research nurses were trained on the details of patient selection and data abstraction and were unaware of the study objectives. Before abstraction of patient information, the study variables were explicitly defined and a standardized data collection form was created. The 30 variables collected included demographic characteristics, clinical descriptors, medical interventions, adverse events and return visits to the ED. The first nurse reviewed the original patient charts of all cases to determine patient eligibility and then abstracted study data. A second study nurse independently reviewed all cases for completeness and accuracy of data abstraction and, in addition, the principal investigator reviewed selected cases. Differences were resolved by consensus.

Outcome measures

The primary outcomes were proportion of conversion to sinus rhythm before discharge from the ED, length of stay in the ED, final disposition and adverse events. Adverse events within the ED included hypotension or arrhythmia. We also reviewed records for evidence of death, stroke and relapse to atrial fibrillation within 7 days of the index ED visit. Adverse events and other outcomes were ascertained from review of the ED record (physician and nursing progress notes, electrocardiograms, consultations), hospital computerized records and quality assurance reviews. If not noted in the record, we assumed adverse events did not occur. The Ottawa Hospital sees two-thirds of all adult ED visits and is the sole regional cardiology referral centre.

Data analysis

We calculated descriptive statistics using proportions, means or medians with interquartile ranges as appropriate for the data. We used SAS software, Version 9.1, TS level 1M3 (SAS Institute Inc.) for data entry and the

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descriptive statistics. The denominator for calculations was occasionally adjusted if data were missing.

RESULTS

From January 2000 to June 2005, there were 1057 ED patient visits with a primary diagnosis of recent-onset atrial fibrillation or flutter, and among these there were 660 patient visits in which the Ottawa Aggressive Protocol was applied (Fig. 1). Among the 397 visits without aggressive treatment, by far the most common reasons for not attempting cardioversion was that the timing of arrhythmia onset was unclear or greater than 48 hours, or that spontaneous conversion occurred before treatment. The 660 visits for which aggressive treatment was applied involved 341 individual patients. Of these, 107 patients presented more than once during the 5 1/2–year study period. Table 2 provides baseline patient characteristics for all visits, those with atrial fibrillation (95.2%) and those with atrial flutter (4.8%). The overall mean patient age was 64.5 (range 19–92) years, 55.6% were men, the mean duration of arrhythmia before presentation was 8.9 hours and 82.1% had at least 1 previous episode of recent-onset atrial fibrillation. Of note, 12.7% and 5.0% of patients had been taking sotalol and amiodarone, respectively, before the visit.

Emergency department treatment measures and their outcomes are shown in Table 3. As indicated, 39.6% of cases received rate control drugs, 100% received intravenous procainamide and 36.8% subsequently underwent electrical cardioversion. Comparing all cases, those with atrial fibrillation, and those with atrial flutter, the conversion rates were 58.3%, 59.9% and 28.1%, respectively, for procainamide and were 91.8%, 91.0% and 100% for electrical shock. Among these same 3 groups 96.8%, 97.0% and 93.8% were discharged home from the ED, and 90.2%, 90.3% and 87.5% were discharged home with normal sinus rhythm, respectively.

Table 4 shows the adverse outcomes of patients and indicates that ED events occurred in 7.6% of patients, most commonly transient hypotension. Arrhythmias were very uncommon and there were no episodes of torsades de pointes. Overall, 3.2% of patients required admission. No patients had a stroke or died, and 8.6% of patients had a relapse of atrial fibrillation within 7 days requiring further management. No patients suffered adverse events attributable to procedural sedation and analgesia administered for electrical cardioversion.

Treatment time intervals are presented in Table 5, which illustrates the rapidity of care for these patients.

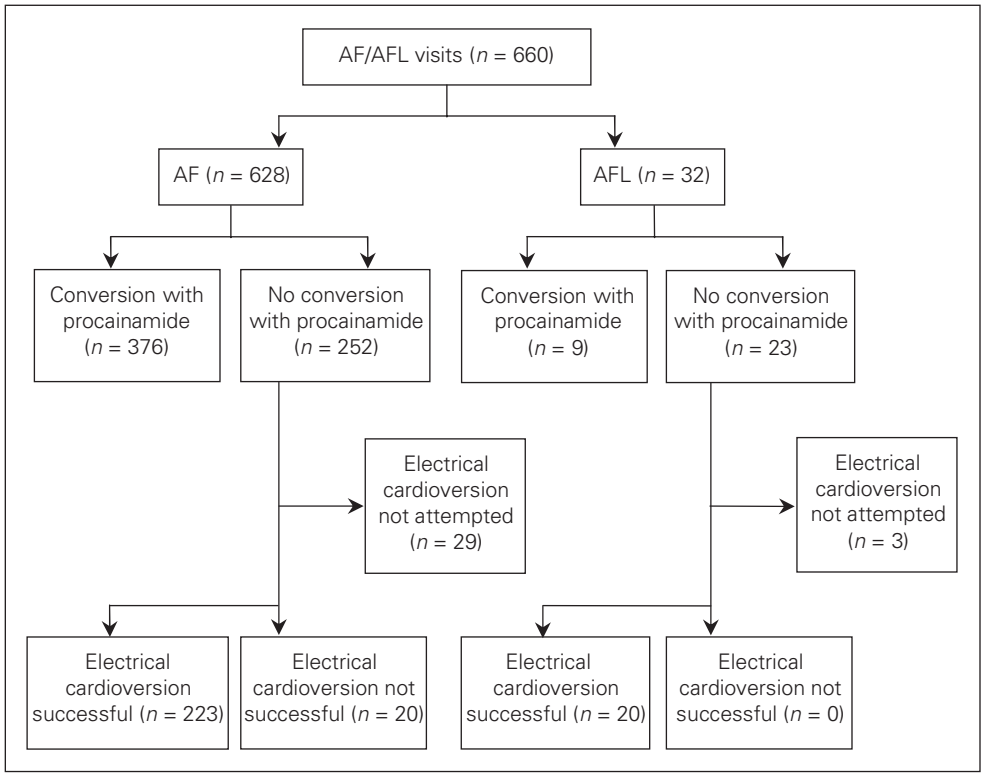

Fig. 1. Flow diagram of treatment for 660 patient visits involving recent-onset atrial fibrillation (AF) and atrial flutter (AFL).

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Comparing all cases, those with atrial fibrillation and those with atrial flutter, the median lengths of stay from ED arrival to discharge were 4.9, 4.8 and 6.3 hours, respectively. These time intervals were shorter for patients who responded to procainamide and longer for those who required electrical cardioversion.

DISCUSSION

To our knowledge, this report of the Ottawa Aggressive Protocol is the largest reported study of an aggressive ED strategy to treat recent-onset episodes of atrial fibrillation or flutter with cardioversion. This large series

Table 2. Baseline characteristics for 660 emergency department patient visits because of recent-onset atrial fibrillation and atrial flutter

	No. (%) of patient visits*		
Characteristic	All patients, *n* = 660	Atrial fibrillation, *n* = 628	Atrial flutter, *n* = 32
Mean age, yr	64.5	64.6	63.0
Range	(19–92)	(19–92)	(32–87)
Male sex	367 (55.6)	346 (55.1)	21 (65.6)
Mean duration of arrhythmia, h	8.9	8.9	9.2
Range	(0.1–144)	(0.1–144)	(0.3–48)
Main presenting symptom			
Palpitations	512 (77.6)	491 (78.2)	21 (65.6)
Chest pain	79 (12.0)	77 (12.3)	2 (6.3)
Shortness of breath	34 (5.2)	29 (4.6)	5 (15.6)
Dizziness	15 (2.3)	15 (2.4)	0 (0.0)
Syncope	5 (0.8)	5 (0.8)	0 (0.0)
Other	15 (2.3)	11 (1.8)	4 (12.5)
Medical history			
Previous atrial fibrillation	542 (82.1)	526 (83.8)	16 (50.0)
Hypertension	278 (42.1)	267 (42.5)	11 (34.4)
Coronary artery disease	141 (21.4)	128 (20.4)	13 (40.6)
Thyroid disease	99 (15.0)	96 (15.3)	3 (9.4)
Valvular heart disease	29 (4.4)	23 (3.7)	6 (18.8)
Congestive heart failure	51 (7.7)	49 (7.8)	2 (6.3)
Thromboembolic disease	44 (6.7)	41 (6.5)	3 (9.4)
Chronic lung disease	40 (6.1)	39 (6.2)	1 (3.1)
Home medications			
β-Blockers	287 (43.5)	271 (43.2)	16 (50.0)
Warfarin	223 (33.8)	212 (33.8)	11 (34.4)
Calcium channel blockers	122 (18.5)	118 (18.8)	4 (12.5)
Sotalol	84 (12.7)	84 (13.4)	0 (0.0)
Digoxin	42 (6.4)	38 (6.1)	4 (12.5)
Amiodarone	33 (5.0)	31 (4.9)	2 (6.3)
Procainamide	8 (1.2)	8 (1.3)	0 (0.0)
Mean heart rate on arrival, beats/min	113.4	112.6	127.5
Mean oxygen saturation on arrival, %	97.8	97.8	97.5
Mean systolic blood pressure, mm Hg	134.4	134.6	130.3
Previous successful cardioversion	438 (66.4)	425 (67.7)	13 (40.6)
Electrical	239 (36.2)	231 (36.8)	8 (25.0)
Procainamide	311 (47.1)	305 (48.6)	6 (18.8)
No. of ED visits during study period			
1	341		
2	108		
3	58		
≥ 4	153		

ED = emergency department.
*Unless otherwise indicated.

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demonstrates the effectiveness and safety of the Ottawa Aggressive Protocol. In our series, 58% of all cases responded to pharmacologic cardioversion and 92% of the remainder responded to electrical cardioversion. The overall effect was that 97% of patients were discharged home from the ED and 90% were discharged home with normal sinus rhythm. This approach proved to be efficient in that the median length of stay of all cases, from ED arrival to discharge, was less than 5 hours. Finally, our findings indicate that the Ottawa Aggressive Protocol is safe in that no patients died or had a stroke or other major adverse event.

Current management of recent-onset atrial fibrillation and flutter in EDs is variable and often very conservative with patients being admitted to hospital under the cardiology service or discharged home after rate control therapy only.[18,23,24] Current cardiology guidelines say very little about the recent-onset management of these arrhythmias with the most recent guidelines on atrial fibrillation from the American College of Cardiology (ACC), American Heart Association (AHA) and European Society of Cardiology (ESC) providing little mention of ED care.[5] Standard emergency medicine textbooks now discuss the option of cardioversion but suggest this is "often in consultation with a cardiologist."[25] Much confusion relates to recent studies such as the AFFIRM (Atrial Fibrillation Follow-up Investigation of Rhythm Management) and AF_CHF (Atrial Fibrillation and Congestive Heart Failure) trials, which compared rate control to rhythm control strategies in patients with asymptomatic or minimally symptomatic persistent or permanent atrial fibrillation.[7,26–29] Their findings do not directly apply to the ED management of recent-onset episodes of symptomatic fibrillation.

Relatively few studies have addressed optimal management of recent-onset atrial fibrillation in the ED, leaving clinicians with a shortage of good evidence. In our institution, Michael and colleagues[3] previously described a small series of patients successfully treated with rhythm control. Other studies of rhythm control in the ED have been small or did not include electrical cardioversion as an option.[8,30,31] Burton and coauthors[10] reviewed 388 electrical conversion attempts at 4 sites where use of pharmacologic cardioversion appeared to be relatively uncommon and reported a 86% conversion rate. Decker and coworkers[18] described the ED observation unit management of 75 patients randomly assigned to a protocol that included electrical but not pharmacologic conversion and was able to discharge 88% of cases. These patients had a median length of stay of 10 hours after admission to the observation unit.

Table 3. Emergency department treatment for 660 patient visits because of recent-onset atrial fibrillation and atrial flutter

	No. (%) of patient visits*		
Treatment	All visits, *n* = 660*	Atrial fibrillation, *n* = 628*	Atrial flutter, *n* = 32*
IV rate control drugs in ED	261 (39.6)	246 (39.2)	15 (46.9)
Metoprolol	175 (26.5)	166 (26.4)	9 (28.1)
Diltiazem	97 (14.7)	91 (14.5)	6 (18.8)
Verapamil	3 (0.5)	2 (0.3)	1 (3.1)
Digoxin	5 (0.8)	5 (0.8)	0 (0.0)
Rhythm control attempted with IV procainamide	660 (100.0)	628 (100.0)	32 (100.0)
Cardioversion successful	385 (58.3)	376 (59.9)	9 (28.1)
Mean dose procainamide, mg	863.0	865.6	812.5
Range	(25–2000)	(25–2000)	(500–1000)
Mean heart rate before conversion, beats/min	117.3	116.5	134.0
Mean heart rate after conversion, beats/min	68.9	68.5	76.2
Electrical cardioversion attempted	243 (36.8)	223 (35.5)	20 (62.5)
Cardioversion successful (*n* = 243/223/20)	223 (91.8)	203 (91.0)	20 (100.0)
Maximum energy used, monophasic, J	360	360	200
Median total no. of shocks given	1.0	1.0	1.0
Range	(1.0–7.0)	(1.0–7.0)	(1.0–2.0)
Disposition			
Discharge home	639 (96.8)	609 (97.0)	30 (93.8)
Discharge home in normal sinus rhythm	595 (90.2)	567 (90.3)	28 (87.5)

ED = emergency department; IV = intravenous.
*Unless otherwise indicated.

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Our protocol, as previously described, uses procainamide as the agent of choice for pharmacologic cardioversion. This drug has been reported to be 60% and 28% effective for atrial fibrillation and flutter, respectively.[20] Our findings suggest that procainamide has an excellent safety profile, even for patients already taking oral antiarrhythmic agents. Several other drugs can be considered for the pharmacologic cardioversion of atrial fibrillation in the ED.[6,8,9,32,33] According to the ACC/AHA/ESC practice guidelines, the following are classes of recommendation for oral or intravenous agents for atrial fibrillation of less than 7 days duration: class I — proven efficacy (dofetilide, flecainide, ibutilide, propafenone); class IIa — proven efficacy (amiodarone); class IIb — less effective (disopyramide, procainamide, quinidine); and class III — should not be used (digoxin, sotalol).[5] The effectiveness of amiodarone for recent-onset atrial fibrillation is not clear in some meta-analyses suggesting it is no more effective than placebo or is associated with adverse reactions.[34–39] Oral propafenone has been recommended for self-treatment by patients with recurrent episodes of atrial fibrillation.[40] Recent trials of vernakalant, an atrial selective, antiarrhythmic agent and currently approved for investigational use only, have demonstrated high efficacy for conversion of recent onset atrial fibrillation.[41,42] Overall, the quality of evidence is relatively weak for rhythm control drugs in recent-onset atrial fibrillation and there remains a need for large comparative clinical trials conducted in the ED.

Table 4. Adverse outcomes for 660 emergency department patient visits because of recent-onset atrial fibrillation and atrial flutter

	No. (%) of patient visits		
Outcome	All visits, *n* = 660	Atrial fibrillation, *n* = 628	Atrial flutter, *n* = 32
ED events	50 (7.6)	46 (7.3)	4 (12.5)
Hypotension (SBP < 100 mm Hg)	44 (6.7)	41 (6.5)	3 (9.4)
Bradycardia (HR < 60 beats/min)	2 (0.3)	2 (0.3)	0 (0.0)
Syncope	0 (0.0)	0 (0.0)	0 (0.0)
Atrioventricular block	2 (0.3)	2 (0.3)	0 (0.0)
Ventricular tachyarrhythmia	1 (0.2)	1 (0.2)	0 (0.0)
Atrial tachyarrhythmia	2 (0.3)	2 (0.3)	0 (0.0)
Torsades de pointes	0 (0.0)	0 (0.0)	0 (0.0)
Admitted	21 (3.2)	19 (3.0)	2 (6.3)
Stroke	0 (0.0)	0 (0.0)	0 (0.0)
Death	0 (0.0)	0 (0.0)	0 (0.0)
Relapse within 7 d	57 (8.6)	55 (8.8)	2 (6.3)

ED = emergency department; HR = heart rate; SBP = systolic blood pressure.

Table 5. Treatment time intervals for 660 emergency department patient visits because of atrial fibrillation and atrial flutter

Treatment time interval	All visits, *n* = 660	Atrial fibrillation, *n* = 628	Atrial flutter, *n* = 32
Median (IQR) arrival to discharge, h			
All patients	4.9 (3.3)	4.8 (3.3)	6.3 (3.7)
Cardioversion with procainamide	3.9 (2.2)	3.9 (2.2)	4.0 (4.3)
Electrical cardioversion	6.5 (2.8)	6.5 (2.9)	6.4 (3.0)
Median (IQR) other intervals, h			
Arrival to start rate control	1.5 (1.0)	1.5 (1.0)	1.5 (1.3)
Start rate control to start procainamide	0.5 (1.0)	0.5 (1.0)	0.4 (1.8)
Arrival to start procainamide	1.6 (1.2)	1.6 (1.2)	1.8 (1.5)
Start procainamide to conversion	0.9 (1.0)	0.9 (1.0)	0.6 (0.2)
Start procainamide to discharge	3.0 (3.2)	2.9 (3.0)	4.5 (4.3)
Arrival to electrical cardioversion	4.9 (2.9)	4.9 (2.8)	4.3 (1.4)
Electrical cardioversion to discharge	1.3 (1.7)	1.3 (1.7)	2.3 (3.2)

IQR = interquartile range.

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Electrical cardioversion is highly effective but there is no consensus on the appropriateness of its use in the ED, the optimal energy settings or the best approach to procedural sedation and analgesia. Our current approach is to start with higher biphasic waveform energy levels such as 100–150 J and to change to anterior–posterior pad positions if the patient is resistant to initial shocks using an anterior pad appraoch. The evidence for these practices, however, is not strong.[43,44] Emergency physicians at our centre are very comfortable in providing intravenous procedural sedation and analgesia for electrical cardioversion, usually with fentanyl and propofol. A physician, nurse and respiratory therapist are all present for electrical cardioversions. The procedure rarely takes longer than 10 minutes and patients are usually ready for discharge within an hour. Our data demonstrate the safety of electrical cardioversion performed in the ED. Some practitioners prefer to go straight to electrical cardioversion without using rhythm control medications, but we find that the extra hour spent attempting pharmacologic cardioversion is more often than not successful and adds very little delay to the patient's care.

Perhaps the most controversial and confusing aspect of ED rhythm control for recent-onset atrial fibrillation and flutter is ensuring that patients do not suffer a stroke. Authoritative guidelines for prevention of thromboembolism predominately address management of permanent atrial fibrillation and fail to provide clear direction for cases of recent-onset atrial fibrillation.[5] Given the lack of evidence to the contrary, our approach has been and remains to cardiovert without heparin or warfarin for most patients as long as there is a very clear history of arrhythmia onset within 48 hours or if there is therapeutic anticoagulation with warfarin. If the onset is unclear but we find an absence of clot by transesophageal echocardiography, we will perform cardioversion and prescribe warfarin.[19,45] Although risk stratification schemes were designed to guide long-term anticoagulation for patients with permanent atrial fibrillation, evidence now supports prescribing warfarin for patients who underwent cardioversion in the ED if their $CHADS_2$ score is 1 or greater (Table 1).[21,22] Such patients need careful follow-up to minimize the risk of bleeding.[46,47]

The strength of this study is that it is the largest to evaluate the effectiveness and safety of an aggressive protocol for cardioversion and quick discharge of patients from the ED with recent-onset episodes of atrial fibrillation or flutter. Our results indicate that the treatment of such patients can be rapidly and safely managed with medications or electrical cardioversion. There are substantial advantages to this approach, such as avoiding unnecessary hospital admissions, lengthy ED stays or the need for patients to be in an unpleasant and debilitating rhythm for up to 4 weeks while awaiting elective outpatient cardioversion. After undergoing cardioversion in the ED, patients are able to immediately resume a normal lifestyle, including return to work or sports activities.

Several limitations must be mentioned. First, retrospective medical record reviews can have problems with missed cases, incomplete charting and review bias and, hence, methodological criteria have been recommended.[48,49] We are confident that we have come very close to meeting these standards with the exception of quantifying interobserver agreement. We captured all possible eligible cases by querying the NACRS database and performing a detailed review by a well-trained study nurse. This was a consecutive and comprehensive cohort of individual patient visits. The reviewers had full access to physicians' notes, nursing progress notes and in-patient records.

Second, this was an observational study with no control group. Nevertheless, this study provides accurate estimates of conversion rates, discharge rates and safety, and these clearly compare very favourably to the standard conservative strategies of hospital admission or discharge with rate control only. For example, the 96.8% ED discharge rate is likely far higher than that seen in most US hospitals. Third, we have limited information about the 400 patients not treated aggressively during the same time period other than that they did not meet the criteria for aggressive cardioversion, in most cases because the onset was not clearly less than 48 hours. Fourth, this study was not conducted prospectively and it is conceivable that, although we believe it is unlikely, some adverse outcomes were missed. Our institution comprises the regional cardiac and neurologic referral centres, and we would expect patients with ongoing problems to be seen at one of 3 campuses affiliated with the Ottawa Hospital in this mid-sized city. A few other issues should be considered when interpreting our results. This is a single-site study and our findings may not necessarily be generalizable elsewhere, although we see no barriers to this approach being adopted by most EDs. We chose to study all visits rather than just individual patients because this gives us a much greater database from which to evaluate effectiveness and safety.

We believe that future clinical trials should compare

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various drug regimens to determine the optimal medication for cardioversion and should also compare the drug-first to shock-first approaches to cardioversion. Studies are also required to better refine the risk of thromboembolism in recent-onset atrial fibrillation and to clarify the role, if any, of heparin and warfarin in this setting. The usefulness of the $CHADS_2$ score in the ED remains unknown and another potential field of future research.

In conclusion, this is the largest study to date to evaluate a unique aggressive protocol of cardioversion for ED patients with recent-onset episodes of atrial fibrillation and flutter. Our results indicate that the Ottawa Aggressive Protocol is effective, safe and rapid, and has the potential to significantly reduce hospital admissions and to expedite ED care.

Competing interests: Dr. Dickinson is a paid consultant to Cardiome Pharma Corp., which is developing the drug vernakalant for rhythm control of atrial fibrillation. None of the other authors receive funding from Cardiome.

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