SYNCHRONIZED EMERGENCY DEPARTMENT CARDIOVERSION OF ATRIAL DYSRHYTHMIAS SAVES TIME, MONEY AND RESOURCES

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Abstract—The strategy of elective synchronized cardioversion (EDCV) of new onset atrial fibrillation/flutter (AF/flutter) compares favorably to that of Emergency Department (ED) rate control and inpatient admission. This 1-year study comprised consecutive ED synchronized cardioversions performed on patients with new onset (< 48 h) AF/flutter; all were hemodynamically stable. A control group was obtained by chart review of all patients meeting the inclusion criteria admitted in the same year who were managed with rate control in the ED and inpatient admission. Thirty ED cardioversions were performed on 24 patients. Twenty-nine of 30 (97%) of ED cardioversions were successful. The mean hospital length of stay (LOS) for the EDCV group, including those admitted, was 22.8 h (95% CI: 1.7–44.0) compared to the control group: 55.6 h (all admitted) (95% CI: 41.6–69.6). Median LOS for the entire EDCV group was 4 h, compared with 39.3 h for the controls (p < 0.001). There was also a significant difference in median hospital charge, including ED care: EDCV group: $1598 vs. controls $4271 (p < 0.001). All of the study patients were contacted by telephone a minimum of 4 weeks after cardioversion to assess for complications, recidivism, and satisfaction. There were no complications in the EDCV group, and all expressed satisfaction with the procedure. Elective synchronized cardioversion in the ED is an effective strategy for management of new-onset AF/flutter and is associated with significant decreases in charges and length of stay as well as a high degree of patient satisfaction. © 2005 Elsevier Inc.

Keywords—atrial fibrillation; electrical cardioversion; atrial dysrhythmia

INTRODUCTION

The purpose of this clinical study was to compare the outcomes and patient charges of the Emergency Department (ED) electrical cardioversion strategy with those of a contemporaneous control group treated in the traditional manner.

METHODS

The dysrhythmia was considered “new onset” even if it represented a recurrence in a patient known to have previously experienced atrial fibrillation (AF)/flutter as long as the current episode was of less than 48 h duration. Patients were also eligible if they were uncertain of the duration of the dysrhythmia but were adequately anti-coagulated (international normalized ratio [INR] > 2). The study site was a community teaching hospital with an ED census of 50,000; the enrolled patients represented a convenience sample, primarily determined by
the availability of the investigators. Patients could be enrolled during all shifts and days of the week. The proposal was submitted to the Institutional Review Board (IRB), which determined that written patient consent was not required because the intervention (synchronized electrical cardioversion for atrial fibrillation of <48 h duration) was an accepted mode of treatment for this condition and the study did not entail randomization to alternative treatment options. However, all patients were made aware that two modes of treatment, ED cardioversion or rate control with admission, were appropriate and available. The IRB did determine that personal or telephone contact of patients in the historical control group would require prior consent; we did not attempt to contact them.

Patients in our Emergency Department with a diagnosis of new onset (<48 h) AF/flutter, were entered into the study at the discretion of the emergency physician (EP). Patients with AF/flutter had an intravenous line placed, continuous cardiac monitoring instituted, and had a 12-lead electrocardiogram (EKG). Additional studies including laboratory tests and chest X-rays were ordered at the discretion of the EP. The technique of cardioversion, including such factors as pad placement, initial and subsequent energy levels chosen, choice of sedative employed, prior and subsequent use of antidyssrhythmics, and use of biphasic vs. monophasic waveform were at the discretion of the treating physician. Sedation and analgesia were the responsibility of the ED physician; anesthesiologists were not present in any case. All comparisons between case and control groups were made using Pearson’s chi-square test with alpha set at .05.

A control group was obtained from a computer-generated list of all ED admitted patients discharged from the hospital during the study months with a primary discharge diagnosis of AF. From this list of 288 patients, we used the method of Systematic Sampling (1,2) to retrospectively select a control group of 30 patients who would have fit our inclusion criteria but were instead managed with rate control and admission. To be included as a control, the onset of AF had to be clearly noted on the chart as less than 48 h and the patient had to have no other discernible indication for admission. The selection process for the control group was to choose every n\textsuperscript{th} patient on the list, confirming or refuting whether that patient would have been a candidate for inclusion in our study had an investigator been present. When that candidate did not fulfill our criteria, the next name on the list (n + 1) was examined in a similar fashion until a qualifying control was found. After successfully enrolling a control patient, the search was continued at the next multiple of n. As the end of the list was reached twice (before 30 controls had been obtained), this process was repeated with the excluded patients removed from the list. This process allowed patients admitted throughout the study period to be equally eligible for inclusion in the control group.

A single investigator, using the same data sheet as for the prospectively enrolled study patients, abstracted all control data. For all patients and controls, actual hospital charges were obtained from the hospital billing office. These charges did not include the professional component of physician services. Telephone follow-up and chart review were used to assess for recidivism and complications.

**RESULTS**

Thirty ED cardioversions were performed on 24 patients ranging in age from 25–82 years with an average age of 63. All cardioversions were performed by the ED physician alone with the exception of three cases in which the cardiologist was present with the EP. Two patients were cardioverted twice and another two were cardioverted three times during the study period. The elective synchronized cardioversion (EDCV) and control groups did not differ with regard to presenting rhythm, time in AF/flutter, gender, age, vital signs on arrival, or chief complaint (Table 1). Eleven of the 30 cardioversions were performed on patients taking coumadin, the duration of atrial fibrillation known to be less than 48 h in every case but one, and that patient’s INR was therapeu-

<table>
<thead>
<tr>
<th>Presenting rhythm</th>
<th>EDCV (n = 30)</th>
<th>Controls (n = 30)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial fibrillation</td>
<td>26 (86.7%)</td>
<td>27 (90%)</td>
<td>0.712‡</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>4 (13.3%)</td>
<td>3 (10%)</td>
<td>0.712‡</td>
</tr>
<tr>
<td>Duration (minutes)</td>
<td>539 ± 702</td>
<td>443 ± 565</td>
<td>0.606*</td>
</tr>
</tbody>
</table>

* Student’s t-test.
‡ Pearson’s chi-square.
† Fisher’s Exact Test (2-tailed).
tic. Ninety-three percent of the EDCV group was sedated with etomidate.

Twenty-nine of 30 (97%) ED cardioversions were successful. Of the 28 cases in which complete data on the number of attempts and energy levels were recorded, 21 patients (75%) required only one attempt. Of all those successfully cardioverted, 15 were converted at low energy levels (<100 watt-seconds), 11 at intermediate levels (≥100 watt-seconds but ≤200 watt-seconds), and 2 were converted at 300 watt-seconds. Of those successfully cardioverted on one attempt, the mean energy level utilized was 132 watt-seconds. Of the 17 successfully cardioverted patients who received 100 watt-seconds (all on either the first or second attempt), 14 patients (82%) did convert at that level; only 3 required higher energy levels. Six patients in the EDCV group were admitted, including the one failed cardioversion. There was only one complication in the EDCV group; a patient with known mitral stenosis became bradycardic while in the ED and had her mitral valve replaced during that admission. The other four had no specific reason for admission although one had anticoagulation started as an inpatient; all were discharged within 48 h. Although there was no inpatient mortality, we have no specific data on complications in the control group.

The mean hospital length of stay (LOS) for the entire EDCV group, including those admitted, was 22.8 h (95% CI: 1.7–44.0) compared to those in the control group whose mean LOS was 55.6 h (all admitted) (95% CI: 41.6–69.6; p < 0.001). Median LOS for the entire EDCV group was 4.0 h and for the control group, 39.3 h; p < 0.001. Median values were used to more fairly account for an EDCV outlier who, after successful cardioversion, stayed 12 days to have her mitral valve replaced (Figure 1). Excluding this single outlier, the mean LOS for the EDCV group was less than one-quarter of that for the controls (11.6 vs. 55.6 h, p < 0.001). Also, due to the significant charge to this single patient, there was no statistically significant difference in mean hospital charges (EDCV group: $4841 [95% CI: 0–$10,347], [min $660 max $81,633] vs. controls: $4846 [95% CI: $3790–$5901], [min $1975–$14,002]; p > 0.999). However, there was a significant difference in median hospital charge, including ED care: EDCV group: $1598 vs. controls $4271 (p = 0.001) (Figure 2). Excluding the patient receiving a valve replacement, the mean hospital charges for the EDCV group were $2194, less than half that of the controls. One hundred percent of the study patients were contacted by telephone, all except one of these at least 3 weeks after cardioversion to assess for complications, recidivism, and satisfaction. The mean time period between cardioversion and follow-up was 19 weeks (range, 9 days–50 weeks), with a median of 17 weeks. Recidivism was confirmed by chart review. There were no thromboembolic events and no patient reported any adverse events during the follow-up period. All but one patient expressed satisfaction with ED cardioversion; that patient subsequently returned, requested and received electrical cardioversion for his recurrent AF. Five patients had recurrent atrial dysrhythmia within 4 weeks of cardioversion.

**DISCUSSION**

Atrial fibrillation (AF) is the most common dysrhythmia treated in the ED with an incidence ranging from 0.2% between the ages of 55 and 64 to 3.5% over 85 years of age (3). The 2000 American Heart Association (AHA) atrial fibrillation/flutter algorithm recommends considering direct current (DC) or chemical cardioversion for AF of <48 h duration; yet there are few data on U.S. ED cardioversion of new-onset atrial fibrillation (4). Chemical cardioversion may require many hours and is impractical in many EDs, such as ours, that lack an observation unit. Van der Watt et al. report a South African ED experience with successful DC cardioversion of 4 cases of AF of <24 h duration (5). Michael et al. attempted ED electrical cardioversion of 80 Canadian patients with an 89% success rate and ED chemical cardioversion of 180 patients with a 50% success rate. There were no thromboembolic complications in any of the 161 patients cardioverted in the ED (6). Koenig et al. describe a U.S. ED experience with an observation-unit protocol where electrical cardioversion was successful in 4 of 5 attempts (7). Our series of 30 cardioversions confirms the utility of an elective ED DC cardioversion strategy in our active community hospital ED.

The risk of a thromboembolic event after cardiover-
sion of new onset AF approaches 1% whether or not anti-coagulation is initiated at the time of presentation (8,9). Weigner reviewed 357 patients with AF of less than 48 h duration who converted to normal sinus rhythm during their hospital course. Spontaneous conversion occurred in 67%, pharmacologic or electrical cardioversion in 29%. There were 3 patients (0.8%) who had cardioembolic events (peripheral embolus, transient ischemic attack [TIA] and cerebrovascular accident [CVA]); all had been managed with rate control and spontaneously converted (8). There were no thromboembolic events in our EDCV group after electrical ED cardioversion. Data suggest that even in patients with a prior thromboembolic event, rate control, anti-coagulation and transesophageal echocardiography (TEE) before cardioversion, risk approaches 1% (9). Our study size was not large enough to draw conclusions about the risk of stroke with this strategy. However, we found no indication that a policy of ED DC cardioversion of patients in new onset AF would pose any inherent additional increase in the risk of stroke.

Recently, the results of the Atrial Fibrillation Follow-up Investigation of Rhythm Management (AFFIRM) trial, comparing rate to rhythm control in patients with AF, concluded that rate control rather than restoration of sinus rhythm was a reasonable long-term strategy for patients with chronic AF (10). Although these results are not directly applicable to the usual ED care of acute AF, it should be noted that four study patients were seen on more than one occasion and cardioverted each time. If a conservative (rhythm control) approach becomes widely accepted, it may be that the number of times cardioversion is attempted—whether in the ED or elsewhere—would be limited.

Although we considered that all cases of new-onset (< 48 h) AF were eligible for DC cardioversion, not all cardiologists would agree. Indeed, the most recent AHA/ACC guidelines imply that risk factors (such as valvular disease, hypertension and thyrotoxicosis) be considered before employing elective cardioversion without prior anti-coagulation or TEE (11). Unfortunately, no clear evaluation of which risk factors may be relevant in this acute setting (as opposed to the long-term risk of embolism with chronic AF) is available.

Limitations include the fact that this study represents a convenience sample based largely on the availability of at least one of the investigators. However, in our institution, the usual management of all cases of stable AF/flutter, including those of new onset, consisted of rate control, anti-coagulation, and admission. Therefore, it is likely that the differences in time and charges we documented represent true differences due to the intervention, rather than a result of selection bias. The control group, although concurrent, was derived by chart review and therefore some historical data, such as the prior occurrence of dysrhythmias and cardioversion, may be incomplete. Finally, we did not mandate a rigid protocol for diagnostic and therapeutic interventions in our patients, leaving that to the discretion of the physician as is the usual practice in our ED. Although this may be advantageous, as it more closely resembles actual clinical practice, it is not inconceivable that such variations as pad placement and choice of sedative agent could have some effect on our results.

The charge and hospital length-of-stay savings with this strategy are not surprising; when there are no other indications for admission, ED-cardioverted patients may return home after the procedure. However, these savings are not universal; the patient who received a mitral valve replacement had a significantly more expensive and longer length of stay than others in the EDCV group. Another important consideration is the high level of patient satisfaction with this procedure. All but one patient in the EDCV group expressed satisfaction with DC ED cardioversion and all chose or stated they would choose to be treated the same way again. The marked decrease in overall hospital days and charges, apparently highly satisfactory outcomes, and very high patient acceptance, implies that this may be the strategy of choice in selected patients with new onset AF and no other indications for admission.

REFERENCES