Early direct current cardioversion or ablation for atrial fibrillation or atrial flutter and acute decompensated heart failure

Fang Shawn Foo, Andrew Kerr, Ruvin Gabriel, David Heaven, Jen-Li Looi, Mayanna Lund, Jamie Voss, Timothy Sutton

ABSTRACT

AIMS: Guidelines recommend initial rate control in haemodynamically stable patients with atrial fibrillation (AF) or atrial flutter (AFL) and acute decompensated heart failure (ADHF). There is limited data on early inpatient rhythm control. We investigated the outcomes of patients managed with early TOE-guided DC cardioversion (DCCV) or ablation.

METHODS: We retrospectively analysed patients admitted to a single centre with AF or AFL and ADHF with LVEF≤40% that underwent inpatient TOE-guided DCCV or ablation. The primary endpoint was the one year composite outcome of mortality or rehospitalisation for heart failure.

RESULTS: We identified 79 patients, including 33 with AF (32 DCCV, one ablation) and 46 with AFL (22 DCCV, 24 ablation). The primary endpoint occurred in 20%. One-year mortality was 2.5%. There were significantly fewer rehospitalisations for arrhythmia or heart failure with AFL-ablation compared to AFL-DCCV (21% vs 64%, p=<0.01). Clinical recurrence of AF or AFL was 43%. At follow-up LV assessment, LVEF>40% was found in 75% (p=<0.01), including 87% of patients without known cardiomyopathy and 82% of patients in sinus rhythm.

CONCLUSION: Early inpatient DCCV or ablation for AF or AFL and ADHF had low mortality rates and rehospitalisation for heart failure with substantial improvement in LV function at follow-up.

Atrial fibrillation (AF) and atrial flutter (AFL) are common in patients with heart failure. Approximately one-third of patients admitted to hospital with acute decompensated heart failure (ADHF) are in AF at presentation. AF has been shown to be an adverse prognostic marker. Management options for AF include either rhythm or rate control strategies, however, a previous large multicentre randomised trial in patients with atrial fibrillation and heart failure failed to demonstrate superiority with either approach.1 This cohort of patients have a high rate of mortality and hospitalisation. Even with a rhythm control strategy, the rate of arrhythmia recurrence is high. In recent years, there have been several small clinical trials of catheter ablation for atrial fibrillation in patients with heart failure that have shown an improvement in markers such as left ventricular ejection fraction (LVEF) and quality of life.2-5 The recent CASTLE-AF trial in patients with symptomatic paroxysmal or persistent AF and heart failure demonstrated that catheter ablation of AF was associated with a significantly lower rate of the composite endpoint of death from any cause or hospitalisation for worsening heart failure compared to medical therapy.6
However, there is a paucity of data on the optimal management strategy for inpatients that are hospitalised for AF or AFL and ADHF and current guidelines recommend an initial rate control strategy.\textsuperscript{7,8} Except for patients with haemodynamic compromise, immediate or very early cardioversion is generally avoided due to the high rate of early recurrence. Initial management with intravenous diuresis and vasodilators often improves the ventricular rates, although further treatment options for rate control may be limited due to the negative inotropic effects of beta blockers and calcium channel blockers. Intravenous digoxin or amiodarone are often used, but in patients with worsening heart failure or persistently poorly controlled ventricular rates, restoration of sinus rhythm may become necessary.

We sought to investigate the outcomes of inpatients with AF or AFL and ADHF managed with early inpatient transoesophageal echocardiogram (TOE) guided direct current cardioversion (DCCV) or ablation.

**Methods**

**Patient selection**

We retrospectively identified patients presenting to Middlemore Hospital between 1 January 2015 to 31 December 2016 with AF or AFL and ADHF with LVEF ≤40\% on echocardiogram who subsequently underwent a TOE-guided DCCV or ablation. Middlemore Hospital, of the Counties Manukau District Health Board, is one of the largest hospitals in New Zealand, serving a population of over 500,000 people. All patients who underwent a TOE during this period were screened. Exclusion criteria included TOE for other indications, elective admissions for a TOE-guided DCCV or ablation, or patients who did not proceed to a DCCV or ablation due to thrombus on TOE or spontaneous reversion to sinus rhythm.

Three subgroups were identified for further analysis: AF, AFL managed with DCCV (AFL-DCCV) and AFL managed with ablation (AFL-ablation).

**Definitions and follow-up**

Clinical paper and electronic records for all patients were reviewed for the one-year period from successful TOE-guided DCCV or ablation. We utilised an average heart rate of greater than 90 beats per minute (bpm) during the 24 hours prior to TOE as a surrogate marker for persisting tachycardia potentially necessitating a rhythm control strategy. A heart rate of 90bpm was selected as this was the cut-off used by the early warning score system in our hospital.

Rehospitalisation for arrhythmia was defined as rehospitalisation for AF, AFL or bradyarrhythmias. Clinical recurrence of AF or AFL was defined as documented AF or AFL on ECG monitoring >24 hours after successful DCCV or ablation during subsequent hospitalisations, clinical attendances or LV assessments.

For follow-up LV assessment, we identified any repeat LV assessment (including transthoracic echocardiograms or cardiac MRI) undertaken within the first year (but at least four weeks after DCCV or ablation to allow time for improvement of LV function). If more than one LV assessment was undertaken during the first year, then the highest LVEF result was selected. Normal LV function = LVEF >50\%, mild LV impairment = LVEF 40–50\%, moderate LV impairment = LVEF 30–40\%, severe LV impairment = LVEF <30\%.

**Primary and secondary endpoints**

The primary endpoint was the one-year composite outcome of all-cause mortality or rehospitalisation for heart failure.

Secondary outcomes were rehospitalisation for arrhythmia or heart failure, sinus rhythm at 24 hours and clinical recurrence of AF or AFL in the first year. LV function on follow-up LV assessment was analysed by treatment subgroups and cardiac rhythm.

**Statistical analysis**

The logrank test was used to analyse the cumulative incidence plots of the primary endpoint. The chi-square test was used to analyse rehospitalisation for arrhythmia or heart failure, sinus rhythm at 24 hours, clinical recurrence of AF or AFL and antiarrhythmic use. Wilcoxon signed rank test was used to analyse the paired before and after LVEF results, while the Fisher’s exact test was used to explore the relationship between cardiac rhythm at follow-up LV assessment and improvement in LV function.
Results

A total of 362 patients underwent TOE between 1 January 2015 to 31 December 2016. We excluded 283 patients who did not meet the inclusion criteria.

In our final cohort of 79 patients, 33 patients had AF (32 underwent DCCV and one underwent ablation) and 46 patients had AFL (22 underwent DCCV and 24 underwent ablation) (Figure 1).

Baseline characteristics are shown in Table 1. In our cohort, the mean age was 60 with a mean BMI of 33kg/m^2. Eighty-two percent were male and 33% had a history of AF or AFL (of which 58% were persistent). There were 18% who had LVEF ≤40% on previous LV assessment (mean 2.4 years prior to admission) while 54% of patients had no prior LV assessment.

There was an average of five days from day of admission to day of TOE. Sixty-seven percent of patients had an average heart rate of greater than 90bpm during the 24 hours prior to TOE. Utilisation of rate control therapy prior to TOE was as follows: beta blockers 85%, calcium channel blockers 29%, digoxin 24%, amiodarone 52%.

Three patients moved to a different region and three were lost to follow. We believe three of those patients are still alive as data from regional electronic medication dispensing records indicate they are still collecting prescriptions.

Primary outcome

The primary outcome occurred in 16 patients (20%) in the overall cohort. This occurred in 27% of the AF subgroup. Event rates were lower in the AFL-ablation subgroup compared to AFL-DCCV but this was not statistically significant (8% vs 23%, p=0.57) (Figure 2). All-cause mortality at one year was 2.5%, with both patients coming from the AF subgroup.

Secondary outcomes

During the first year, 30 patients (38%) were rehospitalised on at least one occasion for arrhythmia or heart failure. This occurred in 33% of patients in the AF subgroup and was significantly less frequent in the AFL-ablation subgroup compared to the AFL-DCCV subgroup (21% vs 64%, p=<0.01) (Figure 3).

Sinus rhythm was maintained at 24 hours in 70 patients (89%). This was lower in the
Table 1: Baseline characteristics, treatment and medications of patients.

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>Overall (n=79)</th>
<th>AF (n=33)</th>
<th>AFL-DCCV (n=22)</th>
<th>AFL-ablation (n=24)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>60.0</td>
<td>57.5</td>
<td>62.6</td>
<td>61.4</td>
<td>0.26</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>33.0</td>
<td>33.6</td>
<td>32.8</td>
<td>32.4</td>
<td>0.85</td>
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<tr>
<td>Male (%)</td>
<td>82</td>
<td>82</td>
<td>82</td>
<td>83</td>
<td>1.00</td>
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<tr>
<td>Current smoker (%)</td>
<td>11</td>
<td>21</td>
<td>5</td>
<td>4</td>
<td>0.17</td>
</tr>
<tr>
<td>Ethnicity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>European</td>
<td>46</td>
<td>52</td>
<td>50</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>27</td>
<td>24</td>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Pacific Island</td>
<td>23</td>
<td>18</td>
<td>23</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Previous AF/AFL (%)</td>
<td>33</td>
<td>36</td>
<td>41</td>
<td>21</td>
<td>0.30</td>
</tr>
<tr>
<td>Paroxysmal (%)</td>
<td>42</td>
<td>44</td>
<td>44</td>
<td>40</td>
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</tr>
<tr>
<td>Persistent (%)</td>
<td>58</td>
<td>58</td>
<td>56</td>
<td>60</td>
<td></td>
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<tr>
<td>Hypertension (%)</td>
<td>38</td>
<td>30</td>
<td>55</td>
<td>33</td>
<td>0.16</td>
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<tr>
<td>Diabetes mellitus (%)</td>
<td>24</td>
<td>15</td>
<td>36</td>
<td>25</td>
<td>0.20</td>
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<tr>
<td>History of IHD (%)</td>
<td>19</td>
<td>18</td>
<td>32</td>
<td>8</td>
<td>0.15</td>
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<tr>
<td>Previous CVA (%)</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>4</td>
<td>0.18</td>
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<tr>
<td>Previous CHF (%)</td>
<td>15</td>
<td>18</td>
<td>14</td>
<td>13</td>
<td>0.86</td>
</tr>
<tr>
<td>Previous CRT/ICD (%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
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<tr>
<td>Previous LV assessment (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.17</td>
</tr>
<tr>
<td>Unknown</td>
<td>54</td>
<td>61</td>
<td>32</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>LVEF &gt;40%</td>
<td>28</td>
<td>18</td>
<td>50</td>
<td>21</td>
<td></td>
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<tr>
<td>LVEF ≤40%</td>
<td>18</td>
<td>21</td>
<td>18</td>
<td>12</td>
<td></td>
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<tr>
<td>Days to TOE</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>0.13</td>
</tr>
<tr>
<td>HR&gt;90 24hr before TOE (%)</td>
<td>67</td>
<td>55</td>
<td>77</td>
<td>75</td>
<td>0.13</td>
</tr>
<tr>
<td>Inpatient rate-control medications (%)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Beta-blocker</td>
<td>85</td>
<td>94</td>
<td>91</td>
<td>67</td>
<td>0.02</td>
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<tr>
<td>Calcium channel blocker</td>
<td>29</td>
<td>33</td>
<td>32</td>
<td>21</td>
<td>0.56</td>
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<tr>
<td>Digoxin</td>
<td>24</td>
<td>36</td>
<td>27</td>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>52</td>
<td>64</td>
<td>50</td>
<td>38</td>
<td>0.15</td>
</tr>
<tr>
<td>Medications at repeat LV assessment (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACE-inhibitor</td>
<td>91</td>
<td>96</td>
<td>82</td>
<td>90</td>
<td>0.36</td>
</tr>
<tr>
<td>Beta blocker</td>
<td>91</td>
<td>96</td>
<td>88</td>
<td>84</td>
<td>0.36</td>
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<tr>
<td>Spironolactone</td>
<td>38</td>
<td>48</td>
<td>12</td>
<td>47</td>
<td>0.03</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>46</td>
<td>52</td>
<td>53</td>
<td>32</td>
<td>0.32</td>
</tr>
<tr>
<td>Anticoagulation</td>
<td>89</td>
<td>93</td>
<td>82</td>
<td>90</td>
<td>0.57</td>
</tr>
</tbody>
</table>

BMI = body mass index, IHD = ischaemic heart disease, CVA = cerebrovascular accident, CHF = congestive heart failure, CRT = cardiac resynchronisation therapy, ICD = implantable cardioverter defibrillator, ACE = angiotensin converting enzyme.
AF subgroup (76%) compared to the AFL subgroups (98%), p < 0.01 (Figure 4A).

Of the 70 patients who maintained sinus rhythm at 24 hours after successful DCCV or ablation, recurrence of AF or AFL was detected in 30 patients (43%) at one year. Recurrence rates were comparable in the overall AF group compared to the overall AFL group (44% vs 42%, p=0.88). There was a trend towards more recurrence in patients with AFL managed with DCCV compared with patients managed with ablation, but this did not reach statistical significance (57% vs 29%, p=0.06) (Figure 4B).

Follow-up LV assessment
There were 63 patients (80%) who had at least one follow-up LV assessment during the first year. Mean time to follow-up LV assessment was 5.3 months. On baseline echocardiography, 22% had moderate LV impairment and 78% had severe LV impairment. On follow-up LV assessment, 75% had LVEF >40%, p<0.01 (Figure 5A).

The improvement in LV function was even more pronounced in patients without pre-existing cardiomyopathy. Of the 54 patients without previously known LVEF ≤40%, 87% had LVEF >40% at follow-up.

Sinus rhythm at follow-up LV assessment was associated with better LV function compared to AF or AFL. Of the 50 patients in sinus rhythm, 82% had LVEF >40%, compared with just 46% of the 13 patients in AF or AFL, p=0.01 (Figure 5B).

There was no significant difference in distribution of LV function when analysed by AF, AFL-DCCV or AFL-ablation subgroups. There was also no difference in distribution...
of LV function in patients with rate-controlled or poorly rate-controlled AF/AFL at the time of repeat LV assessment or the subgroups with clinical recurrence of AF/AFL compared to those with no recurrence.

Medications at follow-up LV assessment

A high proportion of the patients in our cohort were on appropriate therapy for heart failure at follow-up. Ninety-one percent were on ACE-inhibitors, 91% were on beta-blockers and 38% were on spironolactone, which may account for some of the improvement in LV function.

Fifty-two percent were discharged on anti-arrhythmics. Amiodarone was the only anti-arrhythmic agent used. They were prescribed less frequently for the AFL patients (AF 73%, AFL-DCCV 55%, AFL-ablation 21%, p<0.01). At 12 months, 27% of patients remained on anti-arrhythmics.

Discussion

An early rhythm control strategy in our cohort of patients hospitalised with AF or AFL and decompensated heart failure with reduced ejection fraction had a low rate of all-cause mortality and rehospitalisation for heart failure at one year. There were significantly fewer rehospitalisations for arrhythmia or heart failure in the AFL-ablation subgroup compared to the AFL-DCCV subgroup. Maintenance of sinus rhythm at 24 hours was almost 90%, but the rate of clinical recurrence during the first year was over 40%. Seventy-five percent of patients had significant improvement in LV systolic function to an LVEF >40%, particularly in patients without known LV dysfunction or patients in sinus rhythm at follow-up LV assessment.

The annual all-cause mortality in the AF-CHF trial was 10%. ESC-HF Pilot, a

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Figure 4: (A) Sinus rhythm at 24 hours. (B) Clinical recurrence of AF or AFL.

![Figure 4](image)

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Figure 5: (A) Improvement in LV function. (B) LV function by cardiac rhythm.

![Figure 5](image)
prospective multicentre observational survey across Europe, reported an all-cause mortality of 17.4% and a combined all-cause mortality or heart failure hospitalisation of 35.8% at one year in patients who had been acutely hospitalised for heart failure.9 In CASTLE-AF, the overall cohort had a one year all-cause mortality of 3.9–4.7%, with a combined all-cause death or heart failure hospitalisation of 12.5–17.1%.6 A recent prospective international multi-ethnic cohort study in Singapore and New Zealand determined an all-cause mortality of 19% at two years and a combined all-cause mortality and heart failure hospitalisation of 43% at two years in patients with heart failure with reduced ejection fraction.10 In comparison, our cohort had a one year all-cause mortality rate of 2.5% and a combined all-cause mortality and heart failure hospitalisation rate of 20%. However, our cohort was a selected group of patients who were well enough to tolerate a TOE and subsequently undergo DCCV or ablation. Our cohort also had a 10-year younger mean age compared to those studies, with almost half the patients of Māori or Pacific Island ethnic groups. Despite the higher proportion of these two ethnicities residing within our catchment area, these groups were still over-represented. Previous reports from the HF registry in New Zealand have shown that Māori patients present with heart failure 17 years earlier compared to other ethnicities.11

Given the significant improvement in LV function in our cohort, very few patients subsequently had an indication for primary prevention ICDs and only four cardiovascular implantable electronic devices were inserted during the first year, including one permanent pacemaker, one ICD, one CRT-P and one CRT-D.

Sinus rhythm at follow-up LV assessment appeared to be a predictor of better LV function, however the number of patients in AF or AFL at the time of repeat LV assessment was small. Clinical recurrence of AF or AFL was not a predictor of better LV function, however, patients from both groups had further attempts at rhythm control with either DCCV or ablation.

In patients without known LVEF ≤40% prior to the index admission, 87% of patients had a significant recovery in LV function. This suggests that most patients without known LV dysfunction who present with AF or AFL and ADHF have a rate-related cardiomyopathy, with rhythm control resulting in marked improvement in LV function.

Limitations
This was a retrospective analysis on a relatively small number of patients in a single centre with a comparatively short follow-up time.

Indications for an early rhythm control strategy were mixed. Although two-thirds of patients had a surrogate marker for persistent tachycardia as the reason for pursuing a rhythm control strategy, most of the remaining patients were likely to have been managed as such as they were young with presumed recent onset atrial arrhythmia that was clinically felt to be the main driver for their decompensated heart failure.

This analysis did not include patients that may have been too unwell to tolerate a TOE, or patients that were managed with a rate control strategy in hospital.

Given the limitations of our study, a larger prospective multicentre study, randomised to an early rhythm control or rate control strategy with longer follow-up would be needed to confirm our findings.

Conclusions
In our cohort, early TOE-guided DCCV or ablation for patients in AF or AFL with ADHF had low mortality rates and rehospitalisation for heart failure. The AFL subgroup managed with ablation had significantly fewer rehospitalisations for arrhythmia or heart failure compared to DCCV. LV function improved substantially at follow-up, particularly in patients in sinus rhythm or without known cardiomyopathy. This study adds to the growing evidence for rhythm control in patients with atrial arrhythmias and heart failure with reduced ejection fraction, but further confirmatory studies in hospitalised patients with ADHF are required.
Competing interests:
Nil.

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