Practical management of common atrial arrhythmias 1: cardioversion

This is the first in a series of four practical articles highlighting the important management steps for non-cardiologists and non-cardiac electrophysiologists dealing with patients with atrial fibrillation and common atrial flutter. This article will deal with care pathways and management principles for cardioversion of atrial arrhythmias.

Arrhythmias are common, affecting 700 000 patients in the UK. Of these 500 000 have atrial fibrillation, (AF), the incidence of which is rising at 5% per annum (Department of Health, 2005). Syncope and arrhythmias together are high on the list of the top 10 reasons for unplanned hospital admission, and AF alone consumes 1% of the NHS annual budget (Stewart et al, 2004). Arrhythmias, or a co-morbidity, may be the principal cause of many acute medical admissions (Lip et al, 1994; Zarifis et al, 1997). There are no useful data for the UK, but AF is now associated with more than 2.3 million admissions a year to hospital in the USA, so equivalent numbers in the UK would be around 575 000 hospital admissions per annum (Krahn et al, 1995). Of these, about 16% are the primary cause of admission, equating to about 95 000 admissions per annum in the UK. Most of these are unplanned admissions, which steeply increases costs. The Framingham Heart Study reports that AF roughly doubles the risk of death in both sexes, independent of age group, over a 40-year follow-up period.

Health-care costs for new cases of AF are high. In the USA, adjusted total Medicare spending in the first year of a diagnosis of AF was 8.6- to 22.6-fold greater in men, and 9.8- to 11.2-fold greater in women. Second- and third-year costs were increased as well, reflecting the lack of a definitive treatment for a difficult and increasing clinical problem (Benjamin et al, 1998; Wolf et al, 1998; Wattigney et al, 2003).

In the UK, only about 20% of patients with established AF who are eligible for warfarin are being treated with it (National Institute for Health and Clinical Excellence, 2006). At the same time, one in three stroke patients is admitted in AF (National Institute for Health and Clinical Excellence, 2006), suggesting a very strong correlation which could be addressed with better provision of anticoagulation for appropriate cases.

Common atrial flutter must also be distinguished from AF, because modern treatments demand it. Catheter ablation is much underused in the treatment of atrial flutter in the UK. Atrial flutter occurs in conjunction with ischaemic heart disease, heart failure, valvular heart disease and hypertensive heart disease. It may also occur in isolation, and is often incessant, proving resistant to medical treatment and returning after cardioversion. Large numbers of patients with the common type of atrial flutter suffer repeated, unplanned admissions and cardioversions, and currently may never be considered for ablation.

Common atrial flutter has a lifetime occurrence of approximately 1.1%, and has an incidence of 6.8% in patients over 80 years, based on epidemiological studies in 59 000 residents of Wisconsin (Granada et al, 2000). Using these data, the UK would expect 50 000 new cases of atrial flutter each year. Catheter ablation for atrial flutter is extremely safe, and complications are very few (Cauchemez et al, 1996). First-time cure rates are now of the order of 90%, although recurrences are still more common than for catheter ablation for supraventricular tachycardias or Wolff–Parkinson–White syndrome (Miller and Zipes, 2002), where success rates over 95% are expected. Curative catheter ablation should be offered much more widely, reducing the high cost of recurrent unplanned emergency admissions. The UK only has about 65 cardiologists undertaking ablation, achieving about half the per capita provision of Spain, but a small workforce should be no barrier to referral of the most deserving cases.

Cardioversion for atrial arrhythmias

Patients presenting for the first time with persistent AF will usually be considered for a direct current cardioversion (DCV) (*Table 1*). Persistent AF is defined as being of more than 7 days' duration and is considered chronic if restoration of sinus rhythm is considered impossible or undesirable. Many cases of persistent AF are related to underlying cardiac disease, particularly left ventricular dysfunction and valvular disease. Untreated patients are often highly symptomatic with rapid ventricular rates

Dr Adam P Fitzpatrick *is Consultant Cardiologist and Electrophysiologist,* **Dr Mark Earley** *is Consultant Cardiologist and Electrophysiologist,* **Dr Sanjiv Petkar** *is Staff Grade in Cardiac Electrophysiology,* **Dr Ihab Diab** *is Clinical Fellow in Cardiac Electrophysiology,* **Dr David Fox** *is Specialist Registrar in Cardiology and* **Dr Paul Williams** *is Specialist Registrar in Cardiology, Manchester Heart Centre, Manchester Royal Infirmary, Manchester M13 9WL*

Correspondence to: Dr AP Fitzpatrick

and loss of atrioventricular synchrony. Patients with AF have a twofold increase in mortality compared with those in sinus rhythm primarily as a result of an increased risk of stroke and heart failure, with this risk being related to the severity of underlying cardiac disease (Fuster et al, 2001). To avoid the increased mortality, morbidity and high cost of AF, restoring sinus rhythm is desirable whenever possible. However, data in asymptomatic elderly patients with established AF suggest that there is no mortality benefit to striving for sinus rhythm (Van Gelder et al, 2002; Wyse et al, 2002). Data are lacking on younger, fitter patients who naturally have a longer and greater exposure to stroke risk if they remain in AF.

Cardioversion with drugs

Cardioversion of AF can be achieved by drugs or DCV, although there are no direct comparative data. Cardioversion with a drug avoids the need for sedation or anaesthesia, but is probably less effective. Most patients with acute onset of AF return to sinus rhythm spontaneously within 24 hours without the need for treatment (Fuster et al, 2001). In contrast, when AF has persisted for more than a week spontaneous cardioversion is much less likely. It follows that cardioversion of AF with a drug will achieve or accelerate achieving sinus rhythm if given early, and more rarely works if given late (Fuster et al, 2001).

Using drugs for cardioversion of AF causes adverse cardiac events in over 10% of cases. Bradycardias (7.9%), QT interval prolongation (1.5%) and ventricular arrhythmias (1.3%) occur, especially in patients with structural heart disease (Maisel et al, 1997). American College of Cardiology/American Heart Association/European Society of Cardiology guidelines only recommend outpatient drug cardioversion for patients who have no underlying structural heart disease, have normal QT intervals at baseline and have proven safety of a particular drug (Fuster et al, 2001).

Flecainide and amiodarone are commonly used in the UK. Intravenous flecainide (150 mg over 20 minutes) is effective in about 50% of patients. Oral flecainide is effective, but takes longer (Fuster et al, 2001). Flecainide should not be used in patients with structural heart disease. Trials suggest that amiodarone is less effective and slower in achieving sinus rhythm than other antiarrhythmic drugs. Digoxin, a commonly used drug, is helpful in slowing the ventricular rate during AF of less than 7 days duration, but its efficacy in reverting the rhythm to sinus is similar to placebo (Fuster et al, 2001).

Direct current cardioversion

DCV for AF delivers a short high-voltage shock synchronized with the R wave of the electrocardiogram (Fuster et al, 2001). R-wave synchronization is essential to avoid the vulnerable phase of the cardiac cycle, i.e. 60–80 ms before to 20–30 ms after the apex of the T wave, as first described by Lown (1967). Conditions for DCV should always be optimized.

Optimization gives better results

DCV should be optimized to achieve the best results. Transthoracic impedance is 70–80 ohms, and higher impedance reduces success. Optimum conductivity is achieved with adhesive gel pads. Hairy individuals should be shaved. Application during expiration decreases thoracic air volume and transthoracic impedance and increases conductivity. Larger electrode pads or paddles lower impedance, while smaller pads or paddles can concentrate current density resulting in myocardial injury. An adhesive pad diameter of 8–12 cm is recommended (Fuster et al, 2001).

The success of DCV is higher, and the energy requirements are lower, when the paddles are placed in an anteroposterior position (Fuster et al, 2001). If anteroposterior positioning doesn't work, anterolateral positioning can then be attempted.

Modern defibrillators have biphasic waveforms, and current polarity is reversed 5–10 ms after discharge begins. Biphasic waveforms have been associated with a greater first shock efficacy, higher cardioversion rate, fewer total shocks, less requirement for high energy to be delivered, and a lower frequency of dermal injury (ECC

Table 1. Key facts about atrial fibrillation

Demographics	Atrial fibrillation affects 500 000 patients in the UK, rising at 5% per annum
	Atrial fibrillation costs 1% of the total NHS budget
	There are ≈ 50 000 new cases of atrial flutter per annum in the UK
Effects in lives and costs	Atrial fibrillation doubles mortality in all age groups
	Atrial fibrillation increases health spending 8–20-fold
Definitions	Paroxysmal atrial fibrillation lasts for up to 7 days
	Persistent atrial fibrillation lasts for over 7 days
	Established or chronic atrial fibrillation lasts for more than 7 days and attempts to restore sinus rhythm will not have been made or have been abandoned

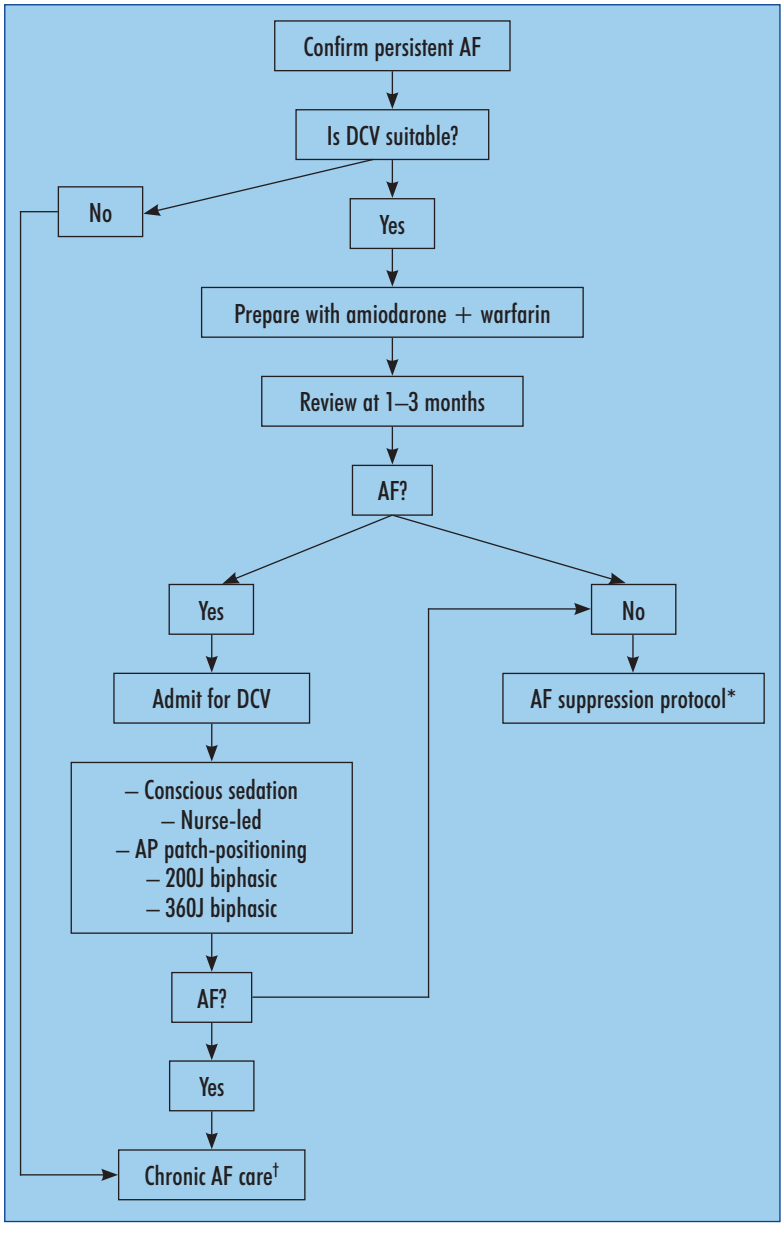
Table 2. Best practice for direct current cardioversion

Where possible, prepare all patients with amiodarone for 1–3 months
Warfarinise patients and maintain international normalised ratio more than 2.0 but less than 3.0 for at least 1 month pre-direct current cardioversion
Conscious sedation is adequate and safe for direct current cardioversion
Nurse-led direct current cardioversion is safe and effective
Adhesive patches should always be used and placed anteroposterior, slightly left of mid-line
High-energy biphasic shocks should be used, starting at 200J
Continue amiodarone and warfarin for 3/12 after direct current cardioversion
Review chronic therapy for maintenance of sinus rhythm in the atrial fibrillation patient (see third article in this series on paroxysmal atrial fibrillation)

Committee, Subcommittees and Task Forces of the American Heart Association, 2005). Monophasic defibrillators do not fit with best practice, and should no longer be used.

Ricard et al (1997) showed that low energy shocks were only effective when AF was <24 hours in duration. However, for AF of longer duration, using a 360 J first shock resulted in a higher chance of achieving sinus rhythm, a lower total cumulative energy delivered to the myocardium and fewer total shocks. Some have suggested that the initial energy setting should be determined by body weight (Rashba et al, 2001). For those patients who weigh <85 kg, the initial starting energy should be 200 J, while in those weighing ≥85 kg it should be 360 J. The joint American College of Cardiology/American Heart Association/European Society of Cardiology Guidelines therefore recommend that an initial energy of 200 J or greater is recommended for electrical cardioversion of AF (Fuster et al, 2001). Using energies of 50–100 J is far more likely to be unsuccessful, and has little to recommend it over a high initial energy. Very high shock energies, i.e. 720 J, have been recommended for resistant cases. The authors recommend starting with 200 J – biphasic.

Figure 1. Care pathway for direct current cardioversion. AF= atrial fibrillation; AP = anteroposterior; DCV= direct current cardioversion. *see third article in this series on paroxysmal atrial fibrillation. † see fourth article in this series on chronic atrial fibrillation.



Dangerous arrhythmias can follow DCV for AF in the setting of hypokalaemia and/or digitalis toxicity (Fuster et al, 2001). Appropriate anticoagulation is essential. Transient ST segment elevation may be noted even in the absence of any significant myocardial damage. A rise in CK-MB levels without a rise in troponin T or I has been documented. Myocardial damage from DCV is insignificant (Fuster et al, 2001).

DCV can easily and safely be done under conscious sedation. Patients usually do not require overnight hospitalization. Potassium and digoxin levels should be normal. Similarly, cardioversion is contraindicated in cases of digitalis toxicity because the ventricular arrhythmias provoked can be difficult to terminate. Shelton et al (2006) showed that a nurse-led, protocol driven, DCV service using conscious sedation is feasible, cost effective and safe.

Thromboembolism in DCV for AF without underlying structural heart disease and of ≤ 48 hours in duration is rare (Fuster et al, 2001). For AF of longer duration, when there is previous thromboembolism, mitral valve disease or left ventricular dilatation, patients should first be anticoagulated for 3–4 weeks. Thromboembolic events have otherwise been reported in up to 7% of patents (Fuster et al, 2001). If anticoagulation is not possible before DCV in AF, trials show that a transesophageal echo-guided strategy is safe, when the left atrial appendage is shown to be free of thrombus (Klein et al, 2006). In AF that has lasted more than 48 hours, all patients should be anticoagulated for at least 4 weeks (Fuster et al, 2001).

Patients appropriately treated with an antiarrhythmic drug before attempted DCV of persistent AF have a higher success rate. Pre-treatment with amiodarone greatly increases the chance of successful DCV for AF, and the chances of restoring sinus rhythm. The overall success rate for DCV is 75–93%. Success is inversely related to duration of AF and to left atrial size (Fuster et al, 2001). Older age, underlying heart disease and cardiomegaly were other predictors of DCV failure. If AF has been present for longer than 5 years, the initial success of DCV is only 50%. Some studies show poor long-term results (Fuster et al, 2001), with only 23% of patients remaining in sinus rhythm after 1 year and 16% after 2 years. However, as with acute success of DCV in AF, the use of amiodarone improves maintenance of AF at 2 and 12 months.

In some cases of resistance to external DCV, for example when patients are very obese and delivered energy to the atria might be consequently reduced, internal cardioversion may be used (Schmitt et al, 1996). However, best practice in external DCV, using optimum conditions, is happening very rarely in the UK, and adopting best practice would leave very few patients needing an invasive approach (*Figure 1*).

Future articles in this series

The second article of the series will focus on management of atrial flutter, the third will look at how to treat patients with paroxysmal atrial fibrillation and, finally, the fourth and concluding article of the series will deal with management of chronic atrial fibrillation. **BJHM**

Conflict of interest: none.

Benjamin EJ, Wolf PA, D'Agostino RB, Silbershatz H, Kannel WB, Levy D (1998) Impact of atrial fibrillation on the risk of death: The Framingham Heart Study. *Circulation* **98:** 946–52

Cauchemez B, Haissaguerre M, Fischer B, Thomas O, Clementy J, Coumel P (1996) Electrophysiological effects of catheter ablation of inferior vena cava-tricuspid annulus isthmus in common atrial flutter. *Circulation* **93:** 284–94

Department of Health (2005) *National Service Framework for Coronary Heart Disease*. Chapter Eight: Arrhythmias and Sudden Cardiac Death. Department of Health, London http://www.dh.gov.uk/assetRoot/04/10/52/80/04105280.pdf

ECC Committee, Subcommittees and Task Forces of the American Heart Association (2005) American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: Part 5: Electrical Therapies Automated External Defibrillators, Defibrillation, Cardioversion, and Pacing. *Circulation* **112:** IV-35–IV-46

Fuster V, Ryden LE, Asinger RW et al (2001) ACC/AHA/ESC guidelines for the management of patients with atrial fibrillation: 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 and Policy Conferences (Committee to Develop Guidelines for the Management of Patients With Atrial Fibrillation). *Eur Heart J* **22:** 1852–923

Granada J, Uribe W, Chyrou PH et al (2000) Incidence and preditors of atrial flutter in the general population. *J Am Coll Cardiol* **36:** 2242–6

Klein AL, Grimm RA, Jasper SE et al (2006) ACUTE Steering and Publications Committee for the ACUTE Investigators. *Am Heart J* **151**(2): 380–9

Krahn AD, Manfreda J, Tate RB, Mathewson FA, Cuddy TE (1995) The natural history of atrial fibrillation: incidence, risk factors, and prognosis in the Manitoba Follow-Up Study. *Am J Med* **98**(5): 476–84

Lip GY, Tean KN, Dunn FG (1994) Treatment of atrial fibrillation in a district general hospital. *Br Heart J* **71(1):** 92–5

Lown B (1967) Electrical reversion of cardiac arrhythmias. *Br Heart J* **29:** 469

Maisel WH, Kuntz KM, Reimold SC, Lee TH, Antman EM, Friedman PL, Stevenson WG (1997) Risk of initiaiting antiarrhythmic drug therapy for atrial fibrillation in patients admitted to a university hospital. *Ann Intern Med* **127**(4): 281–4

Miller JM, Zipes DP (2002) Catheter ablation of arrhythmias. *Circulation* **106:** 203–4

National Institute for Health and Clinical Excellence (2006) *Atrial Fibrillation.* Clinical Guideline 36. National Institute for Health and Clinical Excellence, London: 1-49

Rashba EJ, Bouhouch R, Koshy S, MacMurdy K, Shorofsky SR, Peters RW, Gold MR (2001) A new algorithm for transthoracic cardioversion of atrial fibrillation based on body weight. *Am J Cardiol* **88:** 1043–5

Ricard P, Levy S, Trigano J et al (1967) Prospective assessment of the minimum energy needed for external electrical cardioversion of atrial fibrillation. *Am J Cardiol* **79**(6): 815–16

Schmitt C, Alt E, Plewan A, Ammer R, Leibig M, Karch M, Schomig A (1996) Low energy intracardiac cardioversion after failed conventional external cardioversion of atrial fibrillation. *J Am Coll Cardiol* **28**(4): 9949

Shelton RJ, Allinson A, Johnson T, Smales C, Kaye GC (2006) Four years experience of a nurse-led elective cardioversion service within a district general hospital setting. *Europace* **8**(1): 81–5

Stewart S, Murphy N, Walker A, McGuire A, McMurray JJ (2004) Cost of an emerging epidemic: an economic analysis of atrial fibrillation in the UK. *Heart* **90:** 286–92

Van Gelder IC, Hagens VE, Bosker HA et al (2002) A comparison of rate control and rhythm control in patients with recurrent persistent atrial fibrillation. *N Engl J Med* **347:** 1834

Wattigney WA, Mensah GA, Croft JB (2003) Increasing trends in hospitalization for atrial fibrillation in the United States, 1985 through 1999: implications for primary prevention. *Circulation* **108:** 7116

Wolf PA, Mitchell JB, Baker CS, Kannel WB, D'Agostino RB (1998) Impact of atrial fibrillation on mortality, stroke, and medical costs. *Arch Intern Med* **158**(3): 229–34

Wyse DG, Waldo AL, DiMarco JP et al (2002) A comparison of rate control and rhythm control in patients with atrial fibrillation. The atrial fibrillation follow-up investigation of rhythm management (AFFIRM) investigators. *N Engl J Med* **347:** 1825

Zarifis J, Beevers G, Lip GY (1997) Acute admissions with atrial fibrillation in a British multiracial hospital population. *Br J Clin Pract* **51(2):** 91–6

KEY POINTS

- Atrial fibrillation affects 500 000 patients in the UK, rising at 5% per annum.
- Atrial fibrillation doubles mortality in all age groups.
- Atrial fibrillation costs 1% of the total NHS budget and increases health spending 8–20 fold.
- The UK has ~50 000 new cases of atrial flutter per annum.
- Catheter ablation for atrial flutter is a very effective but underused treatment in the UK.
- External cardioversion, if correctly performed, is useful in achieving sinus rhythm in the short term.
- Pretreatment with amiodarone greatly increases the chance of a successful cardioversion.