CARDIOVASCULAR MEDICINE

Simplified cardioversion service with intravenous midazolam

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Objective: To assess the results of a new cardioversion service that used intravenous midazolam sedation with cardioversion performed with a biphasic defibrillator by an experienced doctor with a prior review of patients in a pre-cardioversion clinic.

Methods: 368 consecutive patients who were treated under the new service over its first 12 months (group 1) were compared with 210 consecutive patients who attended under the old system during the preceding 12 months (group 2). Patients of group 2 had cardioversion under general anaesthesia by junior doctors with a monophasic defibrillator.

Results: There were no anaesthetic or respiratory complications in group 1. Of the patients in group 1, 10.3% remembered the shocks, with only 3.5% considering them unpleasant. Cardioversion was successful in 94.6% of group 1 patients after a mean energy of 117 J compared with 81.4% ($p < 0.0001$) and a mean energy of 242 J ($p < 0.0001$) for group 2 patients. Cancellations on the day of the procedure were reduced from 24% in group 2 to 3.4% in group 1.

Conclusions: The new service was found to be safe and more efficient. It has led to a large reduction in the waiting time for cardioversion.

Following reports of intravenous midazolam and diazepam sedation for cardioversion,^{1,2} we believed that this would simplify the procedure, as an anaesthetist would no longer routinely be needed.³ We reviewed the whole cardioversion process, and changed the defibrillator to a biphasic one, which uses about half the current strength of a monophasic machine.^{4,5} Cardioversions were performed on a session basis by a more senior doctor (medical assistant) experienced in airway management.⁶ All patients were seen two days before cardioversion in a nurse run pre-cardioversion clinic to ensure that international normalised ratios (INRs) had been satisfactory for at least four weeks and that an echocardiogram had been recorded and tests such as for thyroid function had been completed. An ECG was checked, the procedure was explained to the patient and their consent was obtained.

We report a prospective audit of the new service over 12 months and compare the results with those of the preceding year under the old system.

METHODS

Cardioversion process

Cardioversion was performed during a morning session on the cardiology day care ward. Patients were admitted at 8 am after fasting from midnight.

A nurse inserted an intravenous cannula. With patients lying on their backs on a trolley, leads from a Zoll M Series biphasic defibrillator (Zoll Medical UK Ltd, Cheshire, UK) were attached together with a finger oximeter. Oxygen was administered through a facemask. For the first six months an anaesthetist was present but after this time one was available only on call.

After midazolam 2.5 mg was given intravenously, there was a two minute wait before a further 1 mg midazolam bolus was given and repeated at 1-2 minute intervals. The patient was considered adequately sedated when he or she appeared sleepy with the eyelids closed or half closed and no longer continued a conversation. There was no response to soft verbal commands and mild tactile stimuli. When the gel

pads, which were relatively cold, were applied to the chest the patient sometimes stirred, in which case a wait of 1-2 minutes or a further 1 mg of intravenous midazolam was given to reinstate the previous sleepy state. Patients were not sedated down to loss of eyelid reflexes.

With the external paddles pressed manually on to the gel pads below the right clavicle and the left lateral chest wall, an initial shock of 75 J was given (unless the patient had atrial flutter, when 50 J was used). When required, second and third shocks were given at 120 J and 200 J. If the patient was of large build or obese, for the third shock large adhesive electrode pads from Zoll (Pro-PadZ Biphasic Multifunction/Pacing Electrodes) were used. These electrodes were positioned over the right anterior and left lateral chest. The manufacturers advise that these pads may be more successful than external paddles pressed on to gel pads, but they cost £27.50 a pair.

After cardioversion all patients received 200 µg of flumazenil to reverse the midazolam.⁷ Usually the patient then returned to full wakefulness and was able to hold a conversation. The patient was then returned on the trolley to the main section of the day ward and a 12 lead ECG was recorded. The ECG was not monitored. About an hour later, the patient got up, dressed, and then sat out in the ward, but was not observed.

As there is some evidence that β blockade may reduce recurrence of atrial fibrillation (AF),⁸ if the patient was not taking a β blocking drug, 25 mg of atenolol twice daily was prescribed and digoxin was withdrawn. Warfarin was continued in all cases.

Before discharge, the chest wall was inspected and skin burns were graded as 0, no erythema; 1, mild erythema; 2, moderate erythema; and 3, severe erythema with blister formation. The patients were asked if they remembered the

Abbreviations: AF, atrial fibrillation; AFFIRM, atrial fibrillation follow up investigation of rhythm management; INR, international normalised ratio; RACE, rate control versus electrical cardioversion for persistent atrial fibrillation

Table 1 Patients' characteristics, history of atrial fibrillation, and medications

	Group 1 (n=368)	Group 2 (n=210)	p Value
Age (years)	68 (9.5)	67.1 (10.1)	
Men/women	69.3%/30.7%	75%/25%	
Rhythm			
Atrial fibrillation	365	208	
Atrial flutter	3	2	
Cause of atrial fibrillation			
Coronary artery disease	55 (14.9%)	24 (11.4%)	0.25*
Hypertension	163 (44.2%)	74 (35.2%)	0.041
Congestive cardiomyopathy	25 (6.8%)	8 (3.8%)	0.144*
Valvar heart disease	21 (5.7%)	22 (10.5%)	0.033
Post-cardiac surgery	33 (8.9%)	20 (9.5%)	0.796*
Sick sinus syndrome	7 (1.9%)	6 (2.8%)	0.446*
Idiopathic	41 (11.1%)	22 (10.5%)	0.835*
Hyperthyroidism	4 (1.1%)	1 (0.5%)	0.451*
ASD (after Amplatz closure)	2 (0.5%)	2 (1.0%)	0.562*
Not recorded	17 (4.6%)	31 (14.8%)	
Duration of atrial fibrillation (months)			
0-6	112 (30.4%)	11 (5.2%)	<0.0001
6-12	150 (40.8%)	36 (17.1%)	<0.0001
>12	89 (24.2%)	136 (64.8%)	<0.0001
Not known	17 (4.6%)	27 (12.9%)	<0.0001
Antiarrhythmic drugs			
β Blockers	213 (57.9%)	96 (45.7%)	0.007
Amiodarone	74 (20.1%)	18 (8.6%)	<0.0001
Digoxin	137 (37.2%)	67 (31.9%)	0.227*
Flecainide	13 (3.5%)	10 (4.8%)	0.453*
Calcium antagonists	98 (26.6%)	51 (24.2%)	0.578*
Propafenone	1 (0.3%)	0	
Previous cardioversions	27 (7.33%)	62 (29.52%)	<0.0001

*Not significant.

ASD, atrial septal defect.

shocks and if they had found the procedure unpleasant. Dates for follow up ECGs at one and four weeks were arranged.

The patients and results after one year of the new service (group 1) were compared with patients seen during the preceding year (group 2). In the previous service the procedure was performed by junior cardiologists with an anaesthetist specialist registrar. A short general anaesthetic was given with intravenous propofol or sevoflurane by inhalation. The patient was not routinely intubated. A monophasic defibrillator was used with electrode pads placed over the right anterior and the left lateral chest. The protocol of the energy of the shocks was 200 J, 200 J, and then 360 J. If the first two shocks were unsuccessful, the patient was usually turned over to the right side and the next shock was given between the left anterior and left posterior chest wall. As mild to moderate chest wall erythema usually developed after cardioversion in group 2 patients, they were discharged with either hydrocortisone or silver sulfadiazine cream to apply for 2-5 days as necessary.

RESULTS

There were 368 patients in group 1 and 210 in group 2; table 1 shows their clinical details. More patients in group 2 (29.5%) than group 1 (7.4%) had a previous cardioversion ($p < 0.0001$). More patients in group 1 (20.1%) than in group 2 (8.6%) were receiving amiodarone ($p < 0.0001$).

Table 3 Complications of cardioversion in group 1 patients

Apnoea or respiratory problems	0
Skin erythema grade	
0	196 (53%)
1 (mild)	172 (47%)
2 and 3 (moderate to severe)	0
Shocks remembered	38 (10.3%)
Shocks unpleasant	13 (3.5%)
Bradycardia requiring atropine	14 (3.8%)
Bradycardia requiring pacemaker	2 (0.5%)

Cardioversion was successful with 94.6% of patients in group 1 and 81.4% of patients in group 2 ($p < 0.0001$) (table 2). The mean energy of shock needed for cardioversion was 117.5 (56.7) J for group 1 and 242.7 (72.7) J for group 2 ($p < 0.0001$). Zoll Pro-Paz multifunctional/pacing electrode pads were used for 35 patients (9.5%) in group 1. The mean dose of midazolam for group 1 patients was 7.09 (4.76) mg. Two patients were anaesthetised, as they had not become sedated despite 16 mg and 12 mg of midazolam. Complications were recorded prospectively for group 1 patients (table 3) but were not available from the retrospective audit of group 2 patients. No group 1 patients had

Table 2 Cardioversion process

	Group 1 (biphasic system)	Group 2 (monophasic system)	p Value
Number of patients	368	210	
Successful cardioversions	348 (94.6%)	171 (81.4%)	<0.0001
Mean energy of shock	117.52 (56.67)	242.74 (72.66)	<0.0001
Mean number of shocks	1.55 (0.81)	1.96 (0.97)	

any episodes of apnoea or other respiratory complications. They had either no cutaneous reaction or only mild erythema of the chest wall (table 3). No hydrocortisone cream or silver sulfadiazine cream was needed. The shocks were remembered by 10.3% of patients and 3.5% considered them unpleasant.

In group 1, 12 of 380 visits (3.2%) were cancelled on the day of the procedure, as four patients were back in sinus rhythm; eight patients had a low INR and had been added to the list at short notice without being seen at the pre-cardioversion clinic. In group 2, 65 of 275 (24%) visits were cancelled on the day of the procedure (none of the patients in group 2 were seen in a pre-cardioversion clinic). The usual cause for cancellation was inadequate anticoagulant control detected by an INR checked on the morning of the procedure. The waiting time for cardioversion fell from 23 weeks to 12 weeks after the start of the new service, even though another hospital's list of patients for cardioversion had been taken over.

Of 295 patients from group 1 attending for a post-cardioversion ECG, 65 patients (22%) at one week and a further 52 patients at four weeks (for a total of 117 (39.6%) were found to be back in AF.

DISCUSSION

We believe this paper reports the largest sample of patients who have received intravenous midazolam sedation for cardioversion, especially with the use of a biphasic defibrillator. There are concerns that midazolam may lead to respiratory depression down to an anaesthetic level needing the presence of an anaesthetist,⁹ but we have not found this. When midazolam was administered in a slow stepwise manner, oxygen saturations did not fall and usually a lower dose of midazolam was sufficient than when midazolam was given more rapidly. No patient required intubation or another form of respiratory support. The staff grade doctor and day care ward nurses were trained in airway management and resuscitation. Flumazenil was found to reverse promptly the sedative effect of midazolam and no side effects were encountered.⁷

Though the patients jump with the shock, only 10.3% remembered the shock(s) and only 3.5% found them unpleasant. The lower energy (117.5 (56.7) J) and number of shocks (1.5 (0.8)) needed with the biphasic defibrillator reduced the pain and skin reactions. The high cardioversion success rate of 95% compared with the previous rate of 81% with the monophasic equipment has reduced referrals for internal cardioversion after failed cardioversion. However, this higher success rate among group 1 patients was in part due to a larger number receiving amiodarone and a shorter duration of AF than that among group 2 patients (table 1).

Attendance at the pre-cardioversion clinic greatly reduced cancellations on the day of the procedure (from 24% to 3.4%), as problems with low INRs and return to sinus rhythm had already been detected and managed. The new service, with assessment both before and on the day of cardioversion, was more efficient and led to a reduced waiting time from 23 weeks to 12 weeks.

The RACE (rate control versus electrical cardioversion for persistent atrial fibrillation)¹⁰ and AFFIRM (atrial fibrillation follow up investigation of rhythm management) trials¹¹ showed that, for many patients with AF, rate control is sufficient and superior to rhythm control—that is, correction

to sinus rhythm. This implies that, especially for asymptomatic and elderly patients where AF has been an incidental finding, cardioversion is not required. This view may change if new drug regimens are more successful in maintaining sinus rhythm.¹² If a new antithrombin agent, such as ximelagatran,¹³ were successful in a fixed daily dose, the anticoagulant regimen before and after cardioversion would be greatly simplified. We have already noted in the second year of the new service a reduction of cardioversion referrals. For those who do require cardioversion, the regular use of intravenous midazolam with a biphasic defibrillator by a more experienced doctor offers a simple efficient procedure.

Conclusions

This study examined the efficacy and safety of a new service providing cardioversion with intravenous midazolam sedation and a biphasic defibrillator by an experienced senior doctor and assessment of patients in a pre-cardioversion clinic. The audit of the new service has found it to be safe, efficient, and an improvement on the previous service with a monophasic defibrillator and general anaesthesia.

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