

## Randomised controlled trial of cardiac rehabilitation in elderly patients with heart failure

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Received 22 June 2004; received in revised form 26 July 2004; accepted 14 October 2004

Available online 2 February 2005

### Abstract

**Background:** Heart failure, a condition predominantly affecting the elderly, represents an ever-increasing clinical and financial burden for the NHS. Cardiac rehabilitation, a service that incorporates patient education, exercise training and lifestyle modification, requires further evaluation in heart failure management.

**Aim:** The aim of this study was to determine whether a cardiac rehabilitation programme improved on the outcomes of an outpatient heart failure clinic (standard care) for patients, over 60 years of age, with chronic heart failure.

**Methods:** Two hundred patients (60–89 years, 66% male) with New York Heart Association (NYHA) II or III heart failure confirmed by echocardiography were randomised. Both standard care and experimental groups attended clinic with a cardiologist and specialist nurse every 8 weeks. Interventions included exercise prescription, education, dietetics, occupational therapy and psychosocial counselling. The main outcome measures were functional status (NYHA, 6-min walk), health-related quality of life (MLHF and EuroQol) and hospital admissions.

**Results:** There were significant improvements in MLHF and EuroQol scores, NYHA classification and 6-min walking distance (meters) at 24 weeks between the groups ( $p < 0.001$ ). The experimental group had fewer admissions (11 vs. 33,  $p < 0.01$ ) and spent fewer days in hospital (41 vs. 187,  $p < 0.001$ ).

**Conclusions:** Cardiac rehabilitation, already widely established in the UK, offers an effective model of care for older patients with heart failure.

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**Keywords:** Heart failure; Elderly; Cardiac rehabilitation; Functional status; Health-related quality of life; Multidisciplinary intervention

### 1. Introduction

Chronic heart failure presents a major clinical and financial burden for the NHS, one which is likely to increase considerably in the future [1]. Despite the poor prognosis and high hospital admission rate, the management of heart failure is often sub-optimal [2,3]. Effective drugs are under prescribed and interventions that improve patient outcomes such as education, psychosocial counselling and lifestyle modification, are not yet widely available

[4–7]. Cardiac rehabilitation, the main focus of which is exercise, includes all of the aforementioned components and is integral to most cardiology departments. Exercise for patients with stable heart failure has recently been endorsed as a treatment modality [8–10]. Elderly patients who are often under represented, in clinical trials, are perhaps most likely to benefit from such a multidisciplinary approach because of polypharmacy, co-morbidity and poor health-related quality of life. Here, we report on the findings of a randomised controlled trial undertaken, on standard care and intervention groups, to answer the following question: Does a cardiac rehabilitation programme improve physical functioning and health-related quality of life, and reduce admissions in older patients, when added to outpatient treatment for heart failure?

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## 2. Participants and methods

Patients over the age of 60 years with heart failure, New York Heart Association (NYHA) class II or III, and left ventricular systolic dysfunction (ejection fraction  $\leq$  40%), confirmed by echocardiography, were eligible for the study. Patients with diastolic dysfunction were not included. Echocardiographic left ventricular dysfunction was graded semi-quantitatively as mildly, moderately, or severely impaired, in line with the hospital's normal policy. Recruitment was from the acute medical unit, medical and cardiology outpatient clinics at Nevill Hall Hospital, Abergavenny, and general practices in the hospital's catchment area. The sources of recruitment reflected a diversity of healthcare so that the findings would be representative of patients attending a conventional cardiac rehabilitation programme. Patients were screened for enrolment from January 2000 to June 2001, and followed up over a period of 6 months. Patients were excluded if they had significant co-morbidity that would prevent entry into the study because of terminal disease or an inability to exercise (e.g. severe musculo-skeletal disorder, unstable ischemic heart disease, advanced valvular disease), resident outside the catchment area or in a long-term care establishment. Ethical approval was obtained from Gwent Local Ethics Research Committee. All subjects gave written informed consent prior to participation in the study. "The investigation conforms with the principles outlined in the declaration of Helsinki" (Br Med J 1964; ii: 177).

## 3. Randomisation

Prior to randomisation, eligible patients who had given consent were invited to attend for an assessment interview to provide baseline demographic, clinical and psychosocial data. Patients were randomised to one of two interventions, outpatient clinic based care (standard care) or clinic based care plus cardiac rehabilitation (experimental). A computer was used to generate a list of random numbers for the blind randomisation of individual patients. The numbers, placed in plain sealed envelopes by a university colleague prior to patient recruitment, were allocated to the participants by a hospital colleague unconnected with the study. The allocation schedule was not broken until the trial was completed.

## 4. Intervention

Under supervision of a cardiologist, patients in the standard care group received eight weekly monitoring of clinical status (functional performance, fluid status, cardiac rhythm, laboratory assessment) in the cardiology outpatients by the clinical nurse specialist. Participants were

also given an explanation of heart failure and its treatment—self monitoring in regard to the early detection of fluid overload; dietary advice; a patient health record containing a list of their drugs, weights, blood test results, details of future hospital appointments and contact details of the clinical nurse specialist. The flow of participants through each stage of the trial appears in Fig. 1.

In addition to standard care (control group), the experimental regimen consisted of an 8-week cardiac rehabilitation programme that was co-ordinated by the clinical nurse specialist. Patients attended classes twice weekly for a period of 2.5 h. Transport was provided by the hospital for those unable to make their own way. Patients graduated from the programme to a 16-week community based care regimen consisting of weekly 1-h exercise sessions supervised by a British Association of Cardiac Rehabilitation exercise instructor. The exercise classes took place in two community halls, situated at opposite ends of the catchment area. Throughout the programme, patients were encouraged to attend with their spouse or partner. The exercise component was based on the standards set for cardiac rehabilitation and recommendations for exercise training in chronic heart failure patients [10,11]. Patients performed aerobic endurance training and low resistance training/high repetitive muscular strength work. To encourage patients to undertake exercise at the prescribed level, they were issued with the necessary guidance to facilitate exercise for an additional three times per week at home. No adverse events occurred throughout the duration of the exercise regimen.

During the first 8 weeks of the trial, experimental patients received additional education input, during weekly group sessions, on a variety of essential topics (medication, diet, exercise) from members of the multidisciplinary team. These sessions were supplemented with relevant materials. If required, patients and their partners also received individual counselling from the dietician, psychotherapist and occupational therapist.

The following measures were chosen to reflect the impact of the intervention and were applied to all patients in the outpatient clinic setting. The NYHA class I–IV was measured at baseline, 8 and 24 weeks [12]. Subjective bias in regard to this measure was minimised by independent assessments of patients by the clinical nurse specialist and cardiologist. A cardiologist, blind to the standard care or experimental status of the patient, made the final decision on classification for the 5% of patients with disparity in their scores. For the 6-min walk test (6 MWT) performed at baseline and 24 weeks, patients received standardised instructions to walk as far as possible in 6 min on a 33-m course [13–15]. Prior to and immediately on completion of the 6 MWT, symptoms were assessed by means of the 10-point Borg scale rating of perceived exertion (Borg RPE) [16]. All data from the exercise component were collected blindly. Health-related quality of life was measured with the MLHF questionnaire at baseline, 8 and 24 weeks [17,18].

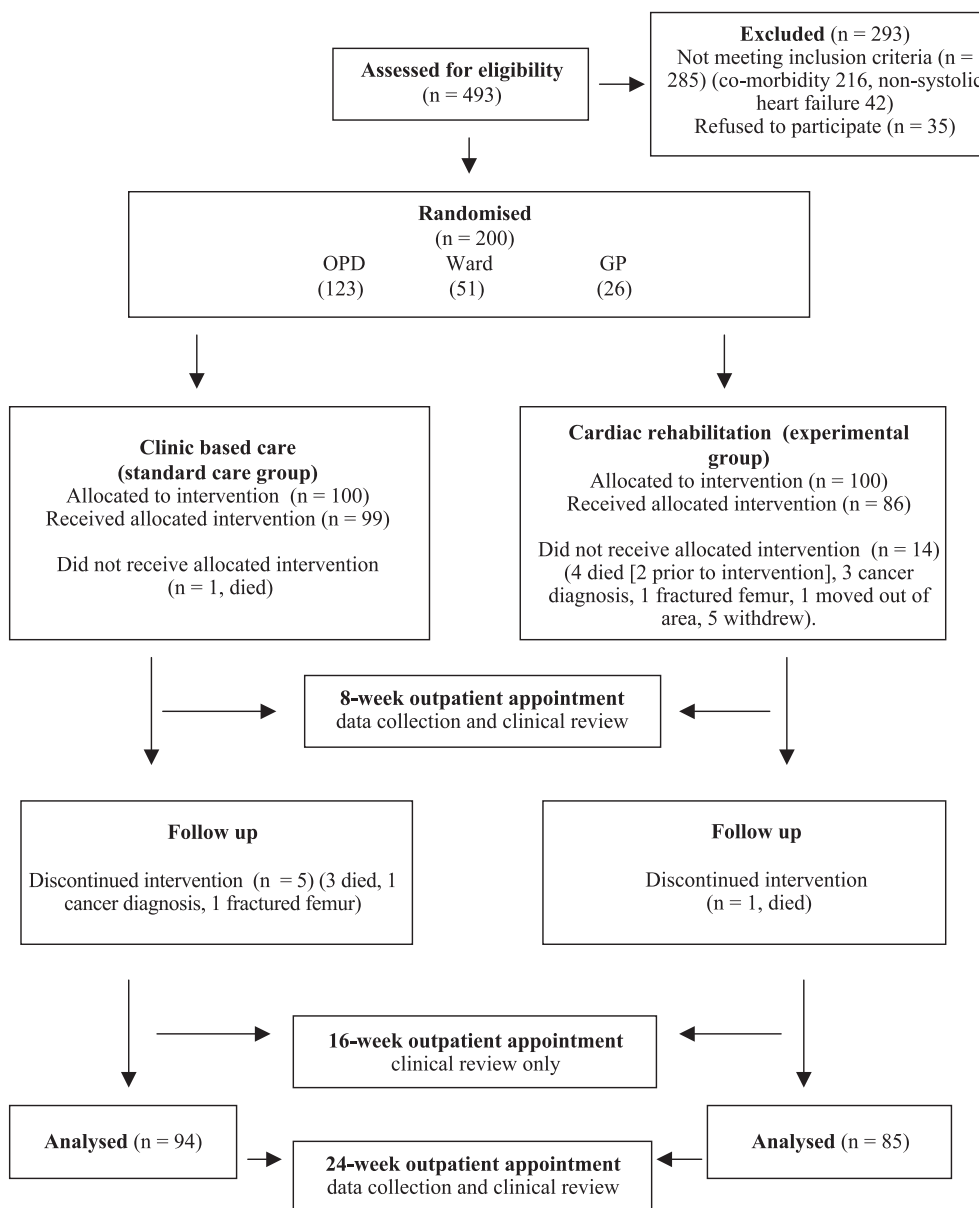


Fig. 1. Flow of participants through each stage of the trial.

The EuroQol a cost utility assessment was undertaken at baseline and 24 weeks [19].

### 5. End points and statistical analysis

The primary end points of this study relate to functional capacity: functional status (NYHA class I–IV), functional performance (6 MWT), perceived exertion (Borg RPE), and health-related quality of life in terms of disease specific (MLHF) and cost utility (EuroQol) questionnaires. The secondary end points include health care utilisation, in terms of the number and length of stay of hospital admissions arising from heart disease, and prescribed heart failure medication. It was not anticipated that mortality would differ between

groups although this was recorded. We obtained data on deaths and admissions from the hospital records department.

Power calculations were performed for health-related quality of life, using a 95% confidence interval. These determined that a sample size of 200 would be sufficient to demonstrate a statistically significant difference between the control and experimental groups, based on a 20% point difference at any point in the distribution. Study data were entered into SPSS (Windows version 10.0) for statistical analysis, on an intention to treat basis. The *t*-test was used to test for between group differences. When assumptions concerning normal distribution were not met, as was the case for biochemistry and NYHA values, the Mann–Whitney *U*-test was used. The chi-square test was used to test for significant differences in categorical data. Changes

in group NYHA classification with respect to baseline were analysed with the Wilcoxon Signed Rank test. Two-tailed tests were used throughout the analysis, and the level of significance was set at  $p < 0.05$ .

## 6. Results

Of the 493 patients screened in this study, 52% were excluded because of their co-morbidity, and 15% of the

Table 1  
Baseline clinical characteristics of patients randomised to standard care or experimental groups

	Standard care (n=100)	Experimental (n=100)	p value
Mean (S.D.) age (years)	71.8 (6.8)	71.9 (6.3)	ns
Male	42 (64)	44 (67)	ns
Sources of recruitment			ns
outpatients	62	61	
ward	28	23	
general practice	10	16	
Primary aetiology			ns
coronary	79	75	
hypertension	14	17	
cardiomyopathy	5	6	
unknown	2	2	
Comorbidity			
Atrial fibrillation	35	23	ns
Renal function			
median			
(interquartile range)			
plasma urea (mmol/l)	7.8 (3.5)	7.6 (5.3)	ns
median			
(interquartile range)			
plasma creatinine (umol/l)	113.0 (30.8)	118.5 (38.5)	ns
diabetes mellitus...	18	19	ns
Mean (S.D.) BMI	28.2 (4.8)	28.2 (4.2)	ns
Degree of left ventricular systolic dysfunction			
mild (ejection fraction $\leq 40$ –35%)	18	15	
moderate (ejection fraction $< 35$ –30%)	41	49	
severe (ejection fraction $< 30$ %)	41	36	
Functional status			
NYHA class			ns
II	47	56	
III	53	44	
6-min walk test—m, mean (95% CI)	256.0 (233.8–278.1)	268.3 (248.6–287.9)	ns
Borg RPE test/post-test median scores	2/2	2/2	ns
Drugs			ns
Patients (%) receiving:			
Loop diuretic	87	88	
ACE inhibitors...	79	84	
$\beta$ -blockers	26	34	
angiotensin II antagonists	8	13	

Values are numbers (percentages) unless stated otherwise. NYHA=New York Heart Association; RPE=Rating of Perceived Exertion; ACE=Angiotensin Converting Enzyme.

Table 2  
Functional performance and quality of life scores

	Standard care		Experimental	
	Mean (95% CI)	p value	Mean (95% CI)	p value
<i>6-min walk test—meters</i>				
Baseline	259.4 (236.3–282.5)		275.5 (254.1–298.8)	
24 weeks	252.7 (226.8–278.5)	ns	320.4 (298.5–342.2)	<0.001
<i>Borg RPE test/post-test</i>				
Baseline	2/2*		2/2*	
24 weeks	3/2*	<0.05	2/1*	<0.05
<i>MLHF scores</i>				
Physical baseline	24.2 (21.8–26.6)		21.5 (19.1–23.9)	
Physical 8 weeks	20.4 (17.9–23.0)	<0.01	13.7 (11.8–15.6)	<0.001
Physical 24 weeks	20.4 (17.8–23.0)	<0.01	12.6 (10.7–14.5)	<0.01
Emotional baseline	9.9 (8.3–11.5)		8.6 (7.1–10.1)	
Emotional 8 weeks	9.1 (7.6–10.6)	ns	5.7 (4.6–6.8)	<0.001
Emotional 24 weeks	8.0 (6.6–9.4)	<0.05	4.4 (3.4–5.3)	<0.01
Total baseline	44.3 (39.5–49.1)		41.0 (36.0–46.0)	
Total 8 weeks	38.8 (33.8–43.8)	<0.05	25.8 (22.3–29.4)	<0.001
Total 24 weeks	36.9 (32.2–41.6)	<0.05	22.9 (19.5–26.4)	<0.01
<i>Euroqol scores</i>				
Baseline	0.65 (0.61–0.70)		0.67 (0.62–0.72)	
24 weeks	0.65 (0.59–0.71)	ns	0.78 (0.75–0.81)	<0.001
<i>Euroqol-vas scores</i>				
Baseline	57.4 (53.7–61.2)		60.8 (57.0–64.6)	
24 weeks	58.4 (54.6–62.1)	ns	70.6 (67.3–73.8)	<0.001

8/24 week groups: standard care n=99/94, experimental n=86/85.

\* Median scores.

eligible patients declined to take part. Table 1 shows the baseline clinical details of the randomised patients. In terms of cardiac dysfunction and classification, the standard care group appears to be slightly worse off than the experimental group. The impact of these differences on physical function is slight as the standard care group shows less than a 5% reduction in the 6 MWT. There are no significant differences in the baseline parameters of the standard care and experimental groups.

Table 2 compares the baseline and intervention values for patients remaining in the study at 24 weeks. Mean walking distance increases significantly by 16% in the experimental group at 24 weeks, in comparison to a slight decrease for the

Table 3  
Change in patient's NYHA functional classification from baseline

NYHA	Standard care			Experimental		
	Baseline (n=100)	8 weeks (n=99)	24 weeks (n=94)	Baseline (n=100)	8 weeks (n=86)	24 weeks (n=85)
Mean (S.D.)	2.53 (0.50)	2.51 (0.50)	2.48 (0.54)	2.44 (0.50)	2.21 (0.41)	2.01 (0.55)
p value		ns	ns		<0.001	<0.001
Change						
–1		8	8		2	3
0		81	76		61	44
+1		10	9		23	35
+2		0	1		0	3
p value		ns	ns		<0.001	<0.001

standard care group. These walking distances are achieved with a significant fall in post-test RPE for the experimental group. For the standard care group, however, there is a significant rise in pre-test RPE. MLHF scores (an inverse rating with health-related quality of life) improve for both groups but for the experimental group all MLHF components (emotional, physical and total) at 8 and 24 weeks are considerably better than baseline values. Standard care group EuroQol and EuroQol-vas scores show little change, in comparison to significant improvements in these measures for the experimental group.

Mean NYHA scores do not change in the standard care group, whereas significant improvements are evident at 8 and 24 weeks in the experimental group (Table 3). At 24 weeks, more patients in the standard care group (81%) remain within their original baseline NYHA classification, than in the experimental group (52%). This difference is a measure of beneficial change in the experimental group, as 45% improve upon their NYHA status in comparison to 11% in the standard care group. At 24 weeks, only 16.5% of the experimental group remain within NYHA class III in comparison to 50% in the standard care group (data not shown).

Hospital admissions for both groups total 228 days, and are equivalent for the two periods covering 1–8 and 9–24 weeks. Table 4 shows that fewer patients in the experimental group (10.6%) are admitted by week 24 than in the standard care group (20.2%). Furthermore, patients in the experimental group have fewer multiple admissions and spend fewer days in hospital. In the standard care group, three patients died in hospital and one patient suddenly at home. Two patients in the experimental group died in the week after randomization, one in hospital (prior to commencing the rehabilitation programme) and the other three at home.

Table 4  
Frequency of hospital admission and mortality at 24 weeks

	Standard care (n=94)	Experimental (n=85)	p value
Patients admitted	19	9	0.2
Total admissions	33	11	<0.01
Days in hospital	187	41	<0.001
Deaths	4	5	>0.2

Hence, mortality rate over this period is similar for both groups, at less than 6%.

Treatment was in compliance with current medication guidelines for both groups. At the end of the study, all patients in the experimental and standard care groups were respectively either on an ACE inhibitor (81% vs. 87%) or angiotensin II antagonist (13% vs. 19%). The enhanced level of prescribing of  $\beta$ -blockers for the experimental group (56% vs. 41%) is a reflection of the increased intervention for this group of patients (data not shown).

## 7. Discussion

The results of this study demonstrate that a multi-disciplinary cardiac rehabilitation programme can improve symptoms, functional performance and health-related quality of life in older patients with systolic heart failure. These benefits are associated with a reduction in hospital admissions attributable to heart disease. Furthermore, we would argue that as the standard care group was seen regularly by a specialist nurse and consultant cardiologist, the demonstrated benefits would be even more evident when compared against an usual outpatient group.

The findings are consistent with those from previous epidemiological studies that have identified a high level of severe co-morbidity in elderly patients with heart failure [20,21]. Screening also confirmed the importance of diagnostic echocardiography; 14% of patients presenting with clinical symptoms were excluded from the study because they were found not to have systolic heart failure. The patients entered into this study had stable heart failure. Consequently, the number of deaths (n=9) during the 6-month period reflects the lower end of the reported annual mortality of 10–50% [22]. In terms of non-completion, our rate is comparable to other heart failure studies [4,6] Only a small number of patients (n=12) decided not to continue with the study, mainly for reasons beyond their control, i.e. the onset of severe co-morbidity, or feelings of anxiety over travel and exercise. The given reasons are typical for an elderly population with physical and psychological frailty. This small number of dropouts does not make the results any less generalisable to a clinical population.

The 6 MWT test offers a convenient, inexpensive, submaximal clinical test of functional performance that is equivalent to normal activity [23]. The improvement in distance walked at 24 weeks (shown by 92% of the experimental group) is equivalent to an improvement in functional performance, the consequence of which is an enhancement of daily activity. The limitation of the walk test, as used in this study, is that it is only an indirect measure of physiological improvement and as such the effect of the exercise programme on the patients' aerobic capacity is unknown. The use of maximal work-load tests with peak oxygen demand would enhance the findings relating to functional change. Currently there are no multidisciplinary heart failure studies that have incorporated exercise as a component with which to compare this result. The conditions imposed on the 6 MWT test are such that the outcome measurements are unlikely to change unless influenced by extremes in well-being, such as an improvement or deterioration in cardio-respiratory symptoms. Hence, the good relationship between NYHA class and distance walked for the standard care and experimental groups. By 24 weeks, 45% of patients receiving cardiac rehabilitation had improved upon their symptomatic status (NYHA functional classification). For some patients, significant benefit was evident at 8 weeks. Further evidence of significant improvement in the patients who received cardiac rehabilitation is supplied by the Borg RPE post-test ratings.

Patients attending cardiac rehabilitation attained a significant improvement in health-related quality of life that is likely to be of clinical importance. The strongest effect occurred in the first 8 weeks, when patients were receiving the most intense phase of the intervention. This element of improvement was found to be particularly lacking for those patients receiving standard care. Stewart et al. [6] reported that significant differences in MLFH total and SF-36 physical scores at 3 months, between community-based and usual care patients, depreciated at 6 months. The findings from the current study suggest, therefore, that cardiac rehabilitation is particularly effective at improving health-related quality of life in the long term, as described by disease specific and utility measures, than a nurse led outpatient clinic or a community based management model. The multidisciplinary intervention of Rich et al. [24], which did not include exercise, reported an improvement in health-related quality of life scores in the short-term only.

In clinical decision making it is important that the complexity of the disease, in terms of its impact on an array of patient outcomes, is taken into account. In theory, this may be undertaken through the determination of patient utility, as measured indirectly in this study by EuroQol, a utility quality of life measure. EuroQol identified a significant difference between the groups in favour of patients receiving rehabilitation. Although patients receiving standard care improved in quality of life as measured by the MLHF, there was no overall health benefit as measured by

EuroQol or EuroQol-vas. It appears, therefore, that the information attained from using the combination of a utility measure, which permits a trade-off between health-related quality of life and life expectancy, and a disease specific measure increases the perspective upon which to judge the value of an intervention. Previous heart failure intervention studies have made claims for cost effectiveness on the basis of reduced hospital admissions, improved health-related quality of life, functional capacity and compliance [6,24–26]. Use of EuroQol within the context of a cardiac rehabilitation RCT provides the clinician with more relevant information on accrued patient benefit in regard to the intervention as a whole.

Cardiac rehabilitation is as effective as specialist nurse and multidisciplinary heart failure interventions in reducing readmission rates over similar follow up periods [4,6,7,24]. However, in the aforementioned studies, all patients were recruited from the ward and these are known to have a higher risk of readmission, especially during the first 6 months [1]. Although the more diverse population in the present study was at reduced risk of readmission, this applies equally to both the standard care and experimental groups.

Alternatives to 'physician led' outpatient care for chronic diseases such as heart failure are under evaluation, particularly in the elderly. As we were testing a 'package of care', already available to a different patient population, this study was not designed to detect a difference in mortality or to assess the components of the programme. It is likely, however, that the increased contact of patients with the rehabilitation team helped to improve on their health-related quality of life, and reduce admissions by earlier identification of deterioration, whilst the exercise programme improved on their functional performance.

Not all patients with heart failure are suitable for such an exercise programme and clearly this care component needs to be tailored to the individual. However, we believe that cardiac rehabilitation should become an important part of the care of heart failure patients, particularly for the elderly. The programme described could easily be adopted in UK hospitals where a basic cardiac rehabilitation service is already provided.

## Acknowledgements

We thank the physicians and nurses working in secondary and primary care for allowing us to study their patients and the cardiac rehabilitation team for their valuable support.

The steering group included Professor Donna Mead (chair), Professor David Cohen, Dr. Jamal Ameen, Peter Bishop Esq, Ron Hudson Esq, Dr. Gareth Jones and Dr. Sinead O'Mahoney. Dr. Tony Davies provided clinical support and Jan Hillman collated the project data. The study was supported by the Nevill Hall Coronary and

Research Thrombosis Fund, the North Gwent Cardiac After Care Charity, Gwent Healthcare Trust, and the University of Glamorgan.

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