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Review

Home-based cardiac rehabilitation compared with centre-based rehabilitation and usual care: A systematic review and meta-analysis

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Abstract

Background: To determine the effectiveness of home-based cardiac rehabilitation programmes compared with (i) usual care and (ii) supervised centre-based cardiac rehabilitation on mortality, health related quality of life and modifiable cardiac risk factors of patients with coronary heart disease.
Methods: Systematic review and meta-analysis of randomised controlled trials. Main outcome measures: mortality, smoking cessation, exercise capacity, systolic blood pressure, total cholesterol, psychological status, and health related quality of life.
Results: Eighteen included trials for home versus usual rehabilitation and six trials of home versus supervised centre-based rehabilitation were identified. The home-based interventions were clinically heterogeneous, trials often small, with quality poorly reported. Compared with usual care, home-based cardiac rehabilitation had a 4 mm Hg (95% CI 6.5, 1.5) greater reduction in systolic blood pressure, and a reduced relative risk of being a smoker at follow-up (RR 0.71, 95% CI 0.51, 1.00). Differences in exercise capacity, total cholesterol, anxiety and depression were all in favour of the home-based group. In patients post-myocardial infarction exercise capacity was significantly improved in the home rehabilitation group by 1.1 METS (95% CI 0.2, 2.1) compared to usual care. The comparison of home-based with supervised centre-based cardiac rehabilitation revealed no significant differences in exercise capacity, systolic blood pressure and total cholesterol.
Conclusions: Current evidence does not show home-based cardiac rehabilitation to be significantly inferior to centre-based rehabilitation for low-risk cardiac patients. However, the numbers of patients included are less than 750 and ongoing trials will contribute to the debate on the acceptability, effectiveness and cost-effectiveness of home-based cardiac rehabilitation.

Keywords: Systematic review; Cardiac rehabilitation; Coronary disease; Home care services

1. Introduction

Cardiac rehabilitation is a multidisciplinary activity that aims to facilitate physical, psychological and emotional recovery and to enable patients to achieve and maintain better health [1]. This is generally achieved through exercise, relaxation and health education, usually provided to groups of patients within a hospital or community setting. There is good evidence that both exercise-only and comprehensive cardiac rehabilitation programmes are effective, reducing all-cause mortality by 27% following a myocardial infarction [2,3]. The National Service Framework for Coronary Heart Disease in England and Wales seeks to expand the uptake and coverage of cardiac rehabilitation to patients following a heart attack, coronary artery bypass graft or coronary angioplasty, and also patients with heart failure and angina [4]. However, using current models of cardiac rehabilitation, this would need considerable protracted investment.

Uptake of hospital-based cardiac rehabilitation programmes is poor, particularly among women, the elderly and people from minority ethnic groups [1]. Home-based cardiac rehabilitation programmes were first reported in the

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early 1980s and might be more acceptable and convenient for some patients, thus increasing uptake. This review explores whether there is any evidence that home-based cardiac rehabilitation programmes are superior to usual care in improving cardiac risk factors and mortality and whether benefits occur to patients' post-myocardial infarction (MI) and after a revascularisation procedure. In addition we have explored whether the outcomes from home-based cardiac rehabilitation are similar to centre (or hospital) -based programmes.

The objective of this systematic review was to critically appraise the available data and determine the effectiveness of home-based cardiac rehabilitation programmes compared with (i) usual care and (ii) supervised centre (or hospital) -based cardiac rehabilitation on mortality, health related quality of life and modifiable cardiac risk factors of patients with coronary heart disease.

2. Methods

We conducted computer searches with standardised search strategies. We searched Medline (1966 to June 2003), EMBASE (1980 to June 2003), CINAHL (1982 to June 2003), and the Cochrane Controlled Trials Register (issue 3, 2003). The search strategy was used to identify randomised controlled trials (RCTs) of home-based cardiac rehabilitation. In addition we manually searched reference lists of retrieved articles and review articles. Unpublished trials were sought by contacting experts in the field and searching conference abstracts. The inclusion of unpublished trials reduces publication bias [5].

Two reviewers (KJ, RT) selected the papers for inclusion using a six question inclusion/exclusion form. Studies included were:

(i) Randomised controlled trials.
(ii) Describing a home-based cardiac rehabilitation programme. Home-based cardiac rehabilitation was defined for the purpose of this review as a structured programme with clear objectives for the participants, that also included monitoring, follow-up, visits, letters or telephone calls from staff, or at least self-monitoring diaries. Studies were excluded if "home-based" was only the control group in a centre-based rehabilitation trial, with no structured programme at home.
(iii) All studies included patients following a myocardial infarction (MI), percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG) or coronary artery disease (CAD). Papers with patients with a mixture of cardiac conditions were included if the majority of patients fell into the included categories.
(iv) The minimal follow-up was to the end of the rehabilitation intervention.
(v) One of the following outcome measures had to be reported: all-cause mortality, cardiac mortality, exercise capacity, smoking behaviour, blood lipid levels, blood pressure, health related quality of life (HRQoL) or health service utilisation.
(vi) The rehabilitation programmes had to include phases II (period immediately post-discharge) and/or III (period from approximately 4 weeks post-discharge), not solely the inpatient rehabilitation (phase 1) or maintenance programme after a supervised group programme had been undertaken (phase IV).

Data was extracted on a standard form by one reviewer (KJ) with double data extraction of a random 20% sample (RT). Where available cholesterol, blood pressure and exercise capacity data were collected as mean (SD) change from baseline for home and comparison groups. Binary outcomes for each trial have been expressed as odds ratios (OR) and 95% confidence intervals (95% CI). Continuous variables have been expressed as the mean change from baseline to follow-up, and the standard deviation of the change from baseline to follow-up for each comparison group. A weighted mean difference and 95% CIs have been calculated for each continuous variable in each trial [6]. Where the standard deviation for change has not been reported in the source papers, allowance was made for within patient correlation from baseline to follow-up measurements by using the correlation coefficient between the two (see Appendix and Cochrane Heart Group web site http://www.epi.bris.ac.uk/cochrane/Information/Resources/stats3.html for details and Follmann et al. [7]). All analyses were performed using Stata v.7 software. Fixed effect models were used in all analyses except where statistical heterogeneity occurred, when a random effect model was used. The trial by Marchionni et al. [8] reported outcomes by age group, so the data are presented separately for three age groups. Where possible outcomes were pooled for the two comparisons — home versus control; home versus hospital using meta-analysis in Stata v.7.

Quality assessment was undertaken as part of the data extraction process. Quality was assessed in terms of the method of randomisation, adequacy of allocation concealment, proportion of patients lost to follow-up and blinding of outcome assessment, and scored using a modified Jadad Scale — the higher the Jadad Score, the higher the quality (possible range 0 to 5). Trials of cardiac rehabilitation cannot be double blinded. A trial scoring 5 would have described itself as an RCT, described the method of randomisation, have adequate allocation concealment, at least 80% follow-up and blinded outcome assessment. The score reflects the reporting of the trial methods and it does not necessarily mean that a low scoring trial was poorly conducted.

3. Results

Fig. 1 shows details of exclusion and inclusion of studies. Tables 1 and 2 show details of the 21 included trials.

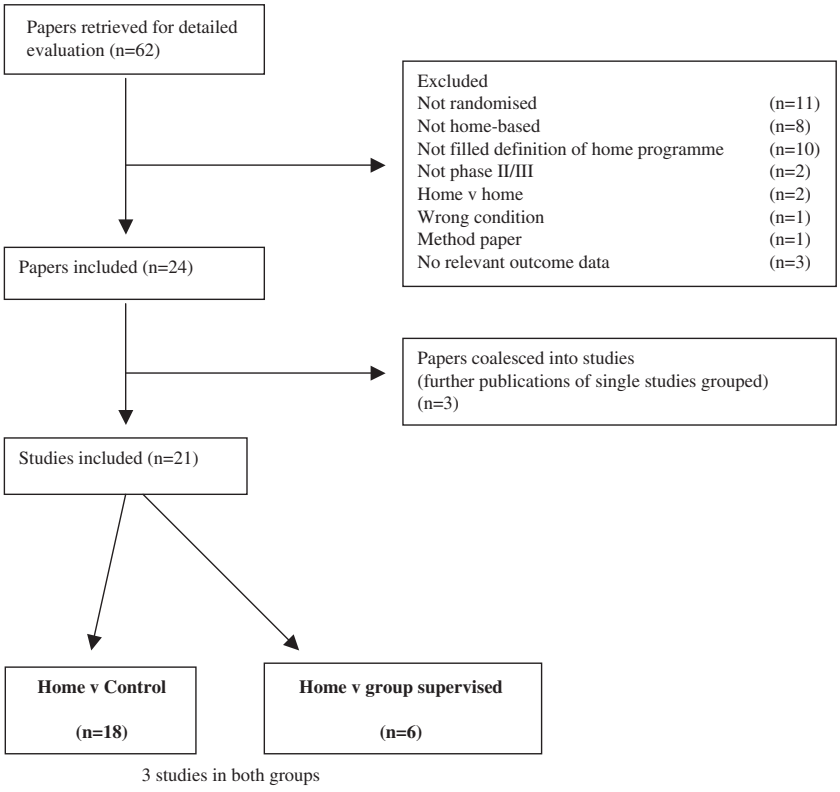

Fig. 1. Flow diagram of systematic review.

3.1. Home-based cardiac rehabilitation compared with usual care

3.1.1. Description of studies

A total of 18 randomised controlled trials were found that compared a home-based cardiac rehabilitation programme to patients receiving "normal care": 9 trials compared a comprehensive home-based cardiac rehabilitation programme with control patients [8–16], 5 an exercise-only programme [17–23] and 4 a predominantly psychological/educational programme [24–27]. Many of the studies were home walking programmes with individually set targets for amount and intensity of exercise, which makes it difficult to quantify the amount of exercise taken. The trials rarely reported on the quantity, duration and nature of lifestyle information. The cardiac rehabilitation programmes were very different: from exercise-based interventions with telemetrically monitored sessions by a nurse [9] to supportive telephone interventions [26]. The majority of the studies (14) recruited a lower risk patient group with exclusion criteria such as significant ischaemia, arrhythmias or heart failure. The proportion of potential participants excluded was usually not reported, but in the 5 studies in which it was reported exclusions ranged from 12.5% for cardiac reasons [15] to 61% overall [9]. Measuring adherence to a home programme of cardiac rehabilitation is very difficult and the majority of the trials did not report adherence. Five used self-report measures and only two trials had objective measures of adherence, but these both used bicycle ergometers for the exercise programme [17–19,21].

3.1.2. Methodological quality

The methodological quality scores of the trials are included in Table 1. Many of the trials give insufficient information to assure their quality, with few authors describing the method of randomisation or confirming the blinding of outcome assessment. Losses to follow-up ranged from approximately 7% [6] to 37% [4], and in some studies, were very different between the intervention and control groups [10,12].

3.1.3. Meta-analyses

Table 3 shows the results of the meta-analyses for all trials combined for the end-points: exercise capacity, systolic blood pressure, total serum cholesterol, the Hospital Anxiety and Depression Score (HADS), the Speilburger State Anxiety Questionnaire, smoking cessation and all-cause mortality. Systolic blood pressure showed a significantly greater fall in the home-based cardiac rehabilitation arm (−4 mm Hg, 95% CIs −6.5 to −1.5). The risk of being a smoker at follow-up was also significantly reduced in the home arm (RR 0.71, 95% CIs 0.51 to 1.00). Exercise capacity, total cholesterol and the HADS all

Table 1
Home-based cardiac rehabilitation compared with "usual care": characteristics of included studies

Study	Participants	Control intervention	Outcome measures							Follow-up	Quality score
			SBP	Cholesterol	Exercise	Smoking	Mortality	HRQoL/Psychological	Health service use		
Comprehensive home rehabilitation programme											
Bell [9]	Post-MI 204 M and F <75 years	Not specified	X	X	X	X	X	HADS	X	1 year	4
Fletcher [10]	Physically disabled men with CAD 88 men aged <74 years	Received dietary guidelines	X	X	X					6 months	1
SCRIP [11]	Post-angiography 259 men and 41 women with CAD<75 years	Not specified	X	X	X	X	X			4 years	4
Heller [12]	Suspected MI 324 men and 126 women	Not specified		X	X		X	QLMI		6 months	3
Lewin [13]	Post-MI 126 men and 50 women	Placebo facilitators' time						HADS, GHQ	X	1 year	4
Linden [14]	Post-MI $N=41$	Placebo facilitators' time				X		HADS		6 weeks	2
Higgins [15]	Post-PTCI 94 M and 11 F	3 monthly post-d/c CHD focussed telephone calls		X	X	X		PAIS			1
Robertson [16]	Post-MI 48 men and 20 women	Not specified							X		3
Marchionni [8]	Post-MI 180 M and F	Single structured education session on risk factors			X			SIP	X	14 months	4
Predominantly psychological/educational home programme											
Taylor [24]	Post-MI 290 M and 88 F <70 years	Not specified					X	Beck dep		12 months	1
Beckie [25]	Post-CABG 60 men and 14 women	Normal in-hospital teaching					X	State anxiety	X	6 weeks	2
Frasure-Smith [26]	Post-MI 903 men and 473 women	Not specified					X	State anxiety, Beck dep		1 year	5
Allen [27]	Post-CABG 138 women	Single pre-discharge group class, guidelines for activity at home			X	X				1 year	3
Exercise-only home cardiac rehabilitation programme											
DeBusk et al. [17–19]	Post-MI 100 men <70 years	2 groups: ETT but no further training; no ETT or training			X		X	State anxiety		23 weeks	2
Heath [20]	Post-CABG 29 men and 8 women	Not specified								6–7 months	2
Brosseau [21]	Post-CABG 66 M and 14 F	Guidelines to increase activity progressively			X						3
Brown [22]	Post-CABG 12 men	Usual exercise programme to increase walking	X		X					12 weeks	2
Aros [23]	Post-MI 118 M <70 years	Encouraged to exercise			X						

SBP, systolic blood pressure; HRQoL, health related quality of life; MI, myocardial infarction; M, male; F, female; CR, cardiac rehabilitation; HADS, Hospital Anxiety and Depression Scale; CAD, coronary artery disease; QLMI, Quality of Life after MI; GHQ, General Health Questionnaire; PTCI, percutaneous transluminal coronary angioplasty; d/c, discharge; CHD, coronary heart disease; PAIS, Psychosocial Adjustment to Illness Scale; SIP, Sickness Impact profile; Beck Dep, Beck Depression Inventory; CABG, coronary artery bypass graft; ETT, exercise tolerance test.

Table 2
Home-based cardiac rehabilitation compared with supervised centre-based rehabilitation: characteristics of included studies

Study	Participants	Home intervention	Centre-based intervention	Outcome measures							Follow-up	Quality score
				SBP	Cholesterol	Exercise	Smoking	Mortality	Health service use	HRQoL/ psychological		
Bell [9]	Post-MI 199 M and F <75 years	Comprehensive CR 6 weeks duration	Varied with hospital studied 1–2 sessions/weeks	X	X	X	X		X	HADS	1 year	4
DeBusk et al. [17–19]	Post-MI 97 men <70 years	Exercise programme Short/long programmes 8 or 23 weeks	Trained in a group with clinical supervision for 8 or 23 weeks			X				State anxiety	23 weeks	2
Carlson [29]	Post-MI or revascularisation 66 M and 14 F <75 years	Comprehensive CR at hospital with weaning to home exercise	Hospital: 3×/week	X	X	X					6 months	2
Sparks [28]	Post-MI or revascularisation 20 M	Comprehensive CR cycle ergometer × 3/week	Comprehensive CR			X					12 weeks	2
Arthur [30]	Post-CABG 197 M and 45 F	Exercise intervention × 3/week Duration: 6 months	Exercise intervention × 3/week Duration: 6 months			X				SF-36 ISEL	3 and 6 months	5
Marchionni [8]	Post-MI 180 M and F	Comprehensive CR Cycle ergometer × 3/week Duration: 2 months	Comprehensive CR × 5/week Duration: 8 weeks			X			X	SIP	2, 8 and 14 months	4

SBP, systolic blood pressure; HRQoL, health related quality of life; MI, myocardial infarction; M, male; F, female; CR, cardiac rehabilitation; HADS, Hospital Anxiety and Depression Scale; CABG, coronary artery bypass graft; SF-36, Short form-36; ISEL, Interpersonal Support Evaluation List; SIP, Sickness Impact Profile.

showed non-significant changes favourable to the home-based rehabilitation arm. Mortality was non-significantly raised in the home-based rehabilitation arm with the results dominated by two trials of predominantly psychological interventions (Fig. 2) [24,26]. Two trials reported a significant reduction in readmission rates in the home-based rehabilitation group following myocardial infarction at 6 weeks [6] and 6 months [3].

Additional psychological outcome measures and health related quality of life (HRQoL) were reported by 5 trials

Table 3
Results of meta-analysis: home-based cardiac rehabilitation versus usual care

	No. of studies	*N*	Pooled estimate	95% CIs		*P* value for heterogeneity
All trials combined						
Exercise capacity (METS) [8–11,15,17–19,21–23]	9	926	0.44	−0.24	1.41	0.9
Systolic blood pressure (mm Hg) [9–11,21,22]	5	574	−4.2	−6.55	−1.51	0.6
Total cholesterol (mmol/l) [9–11,15]	4	579	−0.07	−0.91	0.77	0.5
HADS anxiety score [9,13]	2	294	−0.91	−2.31	0.48	0.3
HADS depression score [9,13]	2	294	−0.29	−1.38	0.81	0.9
State anxiety [17–19,25,26]	3	1430	−5.8	−21.6	9.9	0.8
Smoking (RR of smoking at F/U) [9,11,12,14,15,27]	6	1044	0.71	0.51	1.00	0.4
Mortality (RR of death) [9–11,24,26,27]	6	3053	1.39	0.98	1.97	0.9

Numbers vary from reported numbers in the trials due to loss to follow-up and incomplete reporting of outcomes. No., number; *N*, number; METS, metabolic equivalent or a unit of sitting, resting oxygen uptake; HADS, Hospital Anxiety and Depression Scale; RR, relative risk; F/U, follow-up.

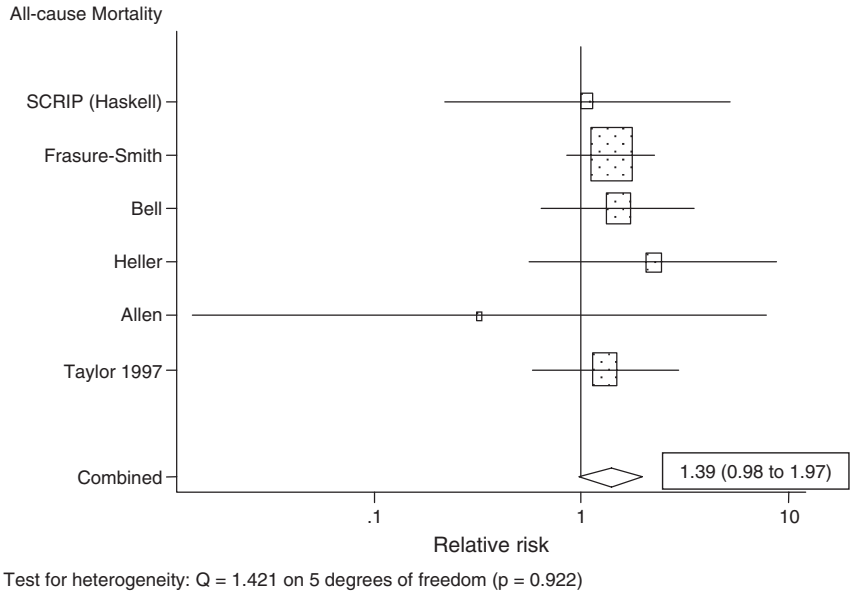

Fig. 2. Meta-analysis results: home-based cardiac rehabilitation versus usual care — mortality. Test for heterogeneity: $Q=1.421$ on 5 degrees of freedom ($P=0.922$).

[9,12,13,15,25]. Improvements in favour of the home-based arms were reported for the Nottingham Health Profile [9], for one of three domains in the Quality of Life after MI Questionnaire [11] and the General Health Questionnaire [3]. No differences were reported for the Psychosocial Adjustment to Illness Scale [5] or single item scales for anxiety, depression, stress and anger [6].

The direction of the results does not differ substantially by the type of home rehabilitation (comprehensive/predominantly psychological/exercise only) or by diagnosis (MI/revascularisation). When rehabilitation post-MI is compared with usual care, the change in exercise capacity is significantly better in the home rehabilitation group: 1.1 METS (95% CI 0.2, 2.1).

3.2. Home-based compared with supervised centre-based cardiac rehabilitation

3.2.1. Description of studies

Six randomised controlled trials comparing a home-based cardiac rehabilitation programme to a comprehensive supervised centre-based cardiac rehabilitation programme were found [8,9,17–19,28–30]. The amounts of exercise undertaken by the comparison groups were very similar. Bell [9] included a hospital programme with a frequency typical of hospitals in the UK, whilst the other studies describe more intensive hospital interventions [Table 2]. All trials excluded patients with cardiac conditions that would have made them at risk of a cardiac event during home exercise (significant ischaemia, arrhythmias or heart failure). In the 4 trials that reported exclusions, at least a third of potential participants were excluded either because of cardiac or other exclusion criteria [8,9,17–19,30]. Four studies reported adherence: as an objective measure [17–19,28] and by self-report [28,29]. In all these studies, patients in the home programme reported higher levels of physical activity or adherence to exercise sessions than those in the centre-based arms.

3.2.2. Methodological quality

Quality assessment scores are given in Table 2. The quality scores ranged from 2 [28,29] to 5 [30]. As with the

Table 4
Results of meta-analysis: home versus supervised rehabilitation

	No. of studies	*N*	Pooled estimate	95% CIs		*P* value for heterogeneity
Exercise capacity (METS) [8,9,17–19,28–30]	6	749	−0.02	−0.3	0.26	0.4
Systolic blood pressure (mm Hg) [9,29]	2	247	1.14	−3.7	6.0	0.4
Total cholesterol (mmol/l) [9,29]	2	148	0.03	−0.29	0.35	0.08
HADS anxiety score [9]	1	139	0.5	−0.65	1.65	–
HADS depression score [9]	1	139	−0.31	−1.26	0.64	–
State anxiety [17–19]	1	93	0.6			–
Smoking (relative risk of being a smoker at follow-up) [9]	1	180	0.55	0.24	1.22	–
Mortality (RR of death) [9]	1	254	1.15	0.47	2.82	–

No., number; *N*, number; METS, metabolic equivalent or a unit of sitting, resting oxygen uptake; HADS, Hospital Anxiety and Depression Scale; RR, relative risk.

previous comparison, many of the trials provided insufficient information to assure their quality. Dropout rates were as high as 16%, whilst losses to follow-up were very different in one study between the home and supervised centre-based groups [28].

3.2.3. Outcomes

Table 4 shows the results for the meta-analysis for the three outcomes: exercise capacity, systolic blood pressure and total cholesterol, together with outcomes reported by one trial only. These show no significant differences between the home- and centre-based rehabilitation, although in this case the direction of change is always slightly in favour of the centre-based arms, except for the risk of being a smoker at follow-up. Two studies reported HRQoL as an outcome measure, with a significantly greater improvement in the PCS subscale of the SF-36 (Short Form-36) questionnaire in the home group than the hospital group, as well as a greater perception of social support in the home group [30] and similar improvements in the Sickness Impact Profile in the home and hospital arms [8].

4. Discussion

We believe that this is the first systematic review of home-based cardiac rehabilitation interventions compared to usual care and centre-based supervised rehabilitation. The current standard practice for cardiac rehabilitation is hospital provision in the UK and many other countries, but home-based programmes are an alternative for low to moderate risk patients. Increasingly, risk stratification is carried out at the time of referral to determine short and long term risk with allocation to a centre-based, home or combination programme. In the majority of the studies included in this review high-risk patients were excluded. Patient preference may have an impact on uptake and adherence to home-based cardiac rehabilitation and there is evidence that white patients who work full- or part-time, and who perceive time constraints are more likely to have a preference for home-based provision [31], but no evidence to support the hypothesis that preference might also be associated with gender [31,32].

We have shown that when compared to usual care, there was a statistically significant reduction in systolic blood pressure and a lower risk of being a smoker at follow-up in the home-based group. These differences are probably large enough to be of clinical significance. We also found non-significant improvements in exercise capacity, total cholesterol and anxiety and depression; whilst this lack of significance may be a function of the sample size, the differences in exercise capacity and in cholesterol were very small. The only change that was not in favour of the home group was total mortality. Whilst it would be preferable to have data on cardiac mortality and time to death, these are not available for the majority of studies reporting all-cause mortality [12,14,24,26,27]. In the comparison between home-based and supervised centre-based cardiac rehabilitation programmes, we found no differences, even in mortality, although the centre-based programmes usually had the most favourable change.

Our findings are also corroborated by evidence from a number of non-randomised studies which have compared home-based with supervised centre-based cardiac rehabilitation] [33–36]. These studies reported the outcomes of rehabilitation in 1436 patients, but no study had follow-up beyond 6 months. Of note, the results of these studies are broadly in line with those of the randomised controlled trials and none showed a significant difference between the improvements in exercise capacity at follow-up. One study reported a marked difference in systolic blood pressure at follow-up in favour of the supervised centre-based group, although this had not been adjusted for the baseline value [36]. No difference was found in the improvement in total cholesterol [34] or in psychological status [33].

There is not a universally recognisable definition of what constitutes a home-based programme. We excluded those studies that focussed on information about the recovery process only. We also produced a definition of a home programme that required some form of staff or at least patient monitoring of their progress. Just receiving written literature about what to expect and to do, without follow-up after discharge was considered inadequate to be included in our systematic review. With such criteria we would have expected this to increase the effect size in comparison to programmes that only provided a written plan of action for after discharge.

This review was hindered by the wide variety of the home-based cardiac rehabilitation interventions, the poor reporting of the quality, the small size of many studies, the poor reporting of adherence to the interventions and the variety of outcome measures used. However, whilst the studies included clinically heterogeneous interventions, this did not cause statistical heterogeneity when the home versus control studies were all combined. To address this, we divided the review of home-based cardiac rehabilitation compared to control care into the three main types of cardiac rehabilitation and by patient diagnosis, and have not found results which differed significantly from the meta-analysis of all trials.

The home-based and centre-based programmes included in this review reported very similar amounts of exercise and similar coverage of lifestyle factors. In contrast the “usual” care of the control groups compared to the home-based programmes was rarely well described. Given that the significant benefits from comprehensive and exercise-only cardiac rehabilitation have been shown mainly in centre-based programmes [2], and with the relatively modest changes found in the home versus control group comparison, it is surprising that we have found no difference between home- and centre-based programmes. It may be that patients were receiving considerable input in the usual

care groups, or that many centre-based programmes do not achieve outcomes in line with best practice, possibly due to insufficient inputs in terms of exercise, psychological support and health education.

In conclusion, this systematic review and meta-analysis suggests that home-based cardiac rehabilitation for low-risk patients does not have significantly poorer outcomes compared to centre-based programmes. However, duration of follow-up is short and there are only limited data on mortality rates and from well conducted RCTs and no information about the relative cost-effectiveness of home- and centre-based programmes. Whilst the evidence for the efficacy and safety of home-based cardiac rehabilitation is amassing, the lack of funding for the service by third party payers means that in the United States home-based cardiac rehabilitation might not become a viable option for patients who are unwilling or unable to participate in cardiac rehabilitation [37].

Appendix A

To estimate the standard error of the difference between baseline and follow-up the following equation was used:

$$\text{Adjusted SE difference} = \left[\left(\mathrm{SD}_1^2/n_1 = \mathrm{SD}_2^2/n_2\right)(1-r)\right]$$

where SD_1 is the SD at baseline; where SD_2 is the SD at follow-up; $\boldsymbol{n}_1$ is the number at baseline and $\boldsymbol{n}_2$ is the number at follow-up. The $\boldsymbol{r}$ value was obtained from the Caerphilly study for follow-up periods of 5 years for over 2000 men. Where this was not available we used a value of 0.5 for $\boldsymbol{r}$.

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