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Review

Relaxation therapy for rehabilitation and prevention in ischaemic heart disease: a systematic review and meta-analysis

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Aims **To establish the effects of relaxation therapy on the recovery from a cardiac ischaemic event and secondary prevention.**

Methods and results **A search was conducted for controlled trials in which patients with myocardial ischaemia were taught relaxation therapy, and outcomes were measured with respect to physiological, psychological, cardiac effects, return to work and cardiac events. A total of 27 studies were located. Six studies used abbreviated relaxation therapy (3 h or less of instruction), 13 studies used full relaxation therapy (9 h of supervised instruction and discussion), and in eight studies full relaxation therapy was expanded with cognitive therapy (11 h on average). Physiological outcomes: reduction in resting heart rate, increased heart rate variability, improved exercise tolerance and increased high-density lipoprotein cholesterol were found. No effect was found on blood pressure or cholesterol. Psychological outcome: state anxiety was reduced, trait anxiety was not, depression was reduced. Cardiac effects: the frequency of occurrence of angina pectoris was reduced, the occurrence of arrhythmia and exercise induced ischaemia were reduced. Return to work was improved. Cardiac events occurred less frequently, as well as cardiac deaths. With the exception of resting heart rate, the effects were small, absent or not measured in studies in which abbreviated relaxation therapy was given. No difference was found between the effects of full or expanded relaxation therapy.**

Conclusion **Intensive supervised relaxation practice enhances recovery from an ischaemic cardiac event and contributes to secondary prevention. It is an important ingredient of cardiac rehabilitation, in addition to exercise and psycho-education.** ***Eur J Cardiovasc Prev Rehabil*** **12:193–202 © 2005 The European Society of Cardiology**

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Introduction

A quantitative review of psychosocial interventions such as stress management, cognitive behavioural therapy, health education and relaxation added to standard medical care for patients with coronary artery disease concluded that these interventions had a substantial effect in reducing distress, blood pressure and cholesterol as well as subsequent mortality and cardiac recurrence [1]. A later review [2] found positive effects of psycho-educational programmes on the same risk factors for cardiac disease and a reduction in cardiac mortality and recurrence of myocardial infarction (MI), but no effect on coronary artery bypass surgery or on anxiety and depression. Neither review provided evidence to recommend any specific form of treatment. Because it is not clear which component is effective, guidelines for cardiac rehabilitation deal with the issue of psychosocial treatment and stress management in a variable way, either recommending [3] or not recommending it [4]. Ades [5] suggested that all cardiac patients should be offered stress management classes, but it was not included as a core component of cardiac rehabilitation [6]. Relaxation therapy has been used in cardiac rehabilitation since

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1970 [7], but the evidence for its effectiveness has not been reviewed.

We define relaxation training or therapy as teaching the individual to induce a reduction of tension within himself, without using external means [8]. Relaxation therapy has been studied for almost a century [9] during which time different forms have been developed. Typically, techniques focus on: attention (active or passive); mental representations, images, and words (including response to cues); small movements or posture changes; muscle contraction and relaxation; breathing instructions; sometimes aided by biofeedback. Teaching may be in groups or individually. Different authors call this variously relaxation therapy, stress management, psychological or nursing intervention, or meditation. Traditional relaxation therapy is intensive, usually involving at least several months of training to master basic skills and education in implementing strategies. The subject learns to notice moments of low and high tension in daily life, to find restful moments for practice and to cope differently with high tension periods. Early warning signals indicate rising tension and need to unwind afterwards. These are secondary relaxation skills, which increase the awareness of stress and motivate better management. Later, abbreviated and simplified forms were developed, culminating in Benson's relaxation response [10], which can be taught in a single session. Subsequently, these simplified forms were expanded with cognitive and educational strategies, which had been present in traditional forms, and included in cognitive behavioural treatment. For this review we were interested in studies that teach relaxation skills as a central part of treatment. Moreover, we were interested as to whether the time spent on teaching relaxation skills affected outcome, so we distinguished between: (1) abbreviated relaxation therapy; (2) full, traditional relaxation therapy; and (3) expanded relaxation therapy (including explicit cognitive treatment).

Our research questions were in patients with myocardial ischaemia: (1) does relaxation training, given as an adjunct to usual care, improve outcome better than usual care, with or without exercise rehabilitation? (2) does relaxation training have any long-term beneficial effect on cardiac outcome? (3) does the effect of relaxation therapy vary with the extent and intensity of training?

Methods

A search was performed of Medline, Embase, Cinahl, PsychInfo and the Cochrane Register of Controlled Trials in February 2005, using the keywords: relaxation techniques, meditation, stress management, autogenic training or biofeedback combined with heart or coronary diseases. In addition, the first author's own files were hand-searched, expert colleagues in the field were contacted, and reference lists in retrieved papers were searched.

For inclusion, studies had to be controlled trials, and any control intervention including usual care was permitted. Trials were included if their participants had myocardial ischaemia in one of its various forms of presentation. Congestive cardiac failure and chronic stable angina pectoris were included, but hypertension without clinical ischaemia was excluded. The intervention had to involve learning and applying relaxation therapy as the primary intervention. Interventions such as massage or listening to music were therefore excluded, even though they may have relaxing effects. Studies that taught relaxation as a secondary and minor component of a more complex intervention were excluded (see below), as were studies using biofeedback alone without relaxation therapy.

The outcome(s) measured had to be clinical and relevant to recovery from myocardial ischaemia or the prevention of future events, in at least one of four categories (physiological, psychological, cardiac or fitness for work). Studies whose objective was to test the short-term effects of relaxation for anxiety secondary to hospital admission (e.g. for MI or cardiac surgery) or to procedures such as catheterization, were excluded, as not containing the notion of recovery from ischaemia. Studies that tested the effect of relaxation on risk factors but not directly on cardiac outcome measures were excluded. The decision to include each study was made by both authors independently, with one disagreement (as a result of interpretation) settled by discussion.

Data extraction

Data were extracted using purpose-designed data extraction sheets (see Table 1). When data were uninterpretable or not in suitable form for combining, this was noted. When data were missing an attempt was made to contact the report's first author in the case of studies published in the past 5 years. In the case of studies that compared relaxation therapy with more than one control group, the control that only differed in respect of relaxation therapy was chosen, to measure the effect of the addition of relaxation therapy.

The intensity of relaxation therapy was graded into three grades (see Introduction) based primarily on the time for practice and the content of the cognitive restructuring. All grades of relaxation training contain an important cognitive component, consisting of at least a rationale for relaxation practice and an explanation of the effects of stress. Grade 1 is abbreviated relaxation training. It consists of teaching a basic relaxation skill using at least one form of instruction with or without biofeedback, which takes approximately 3 h or less of group instruction, or 2 h or less of individual instruction. Grade 2 is full, traditional relaxation training, with longer training, practice of extended skills, and discussion. Grade 3 is expanded relaxation training. It involves grade 2 teaching of relaxation, together with teaching of other coping skills, e.g. for dealing with depression, hostility or anger. The differentiation between grades 1 and 2 is thus based upon the hours of supervised practice, the differentiation between grades 2 and 3 is based upon the cognitive content and coping skills. Interventions that taught other coping skills, but did not provide a longer time for practice of relaxation skills, were classified as grade 1.

All data extraction was performed by both authors independently and disagreements (e.g. of choice of outcome) were settled by discussion.

Outcomes

We extracted data on the following variables: (1) physiological, i.e. resting pulse and blood pressure (systolic and diastolic), maximum watts, heart rate variability (HRV), serum cholesterol and high-density lipoprotein cholesterol (HDL); (2) psychological, i.e. depression and anxiety; (3) cardiac, i.e. frequency of angina attacks, occurrence of arrhythmia and ischaemia, and cardiac events (defined as cardiac death, reinfarction, coronary artery bypass graft or percutaneous transluminal coronary angioplasty) over various periods after learning relaxation; (4) function, i.e. return to work (either partial or whole return to work, when the patient had worked before the illness). We selected for each variable the longest common follow-up time, with interim timepoints in some cases, e.g. for cardiac events.

Quality assessment

The quality of the study reports was assessed in terms of significant threats to internal validity [11]. This was assessed by awarding two points for true randomization or one point for quasi-randomization (used, e.g. to prevent contamination between groups), one point if the assessor was blind to the patient's allocation, and one point for the description of dropouts. The maximum score for quality was four points (modified from Jadad *et al.* [11]). Studies were grouped arbitrarily according to risk of bias: low risk (3 or 4 points), intermediate risk (2 points) and high risk (0 or 1 points). Data on quality and quantitative data on outcomes were extracted by both authors independently, with disagreements resolved by discussion.

Data synthesis

For continuous outcomes measured by different instruments, standardized difference in means was calculated, namely the difference in the mean responses divided by the pooled standard deviation. The effect size was expressed in a statistical form, in which we considered an effect size less than 0.20 as no effect, effect size of 0.21–0.49 as a small effect, 0.50–0.79 as medium effect and effect size 0.80 or greater as a large effect [12]. When more than one outcome measure was used in a study for the same construct, preference was given to those measures most similar to the symptom check list for depression, STAI state for anxiety, and peak treadmill time for maximum watts. For continuous outcomes in the same units (e.g. pulse, blood pressure) the weighted mean difference (WMD) was calculated and the effect was expressed in those units. For dichotomous outcomes such as the cardiac events and return to work, two-by-two tables were set up and the odds ratios and 95% confidence intervals (CI) were analysed. Data were entered into 'RevMan 4.2', and 'Metaview' was used for the analysis (RevMan 4.1; Update Software Ltd., Oxford, UK). Statistical homogeneity was tested and fixed effects were used if $P > 0.10$, otherwise random effects modelling was used and an explanation for heterogeneity between results was sought in clinical terms.

After initially combining all studies, sensitivity analyses were performed when appropriate to test for the effect of internal validity of the study (risk of bias) and marked clinical heterogeneity. The latter was described in terms of trial setting, patient samples, content of control treatment (with or without exercise), and was used qualitatively to interpret the result of each individual meta-analysis. Predefined subgroup analyses were performed to investigate the effect of the grade of relaxation. The results of the meta-analyses were then interpreted in the light of those studies that could not be combined, either because data were not presented in a suitable form (e.g. absent SD, or test statistic only), or because the control group received a different and potentially effective intervention. The latter studies act to the disadvantage of establishing an effect of relaxation therapy. They were nevertheless included except for variables that would be influenced by the intervention: exercise and cardiac data for exercise training and lifestyle data (smoking, cholesterol and sedentary lifestyle) for health education. Funnel plots were constructed using the inbuilt software and were evaluated by inspection.

Results

The searches located 27 studies that met our criteria [7,13–38]. The essential data are set out in Table 1. Thirty-four potentially relevant articles were excluded for using mixed interventions, not using relaxation therapy meeting our definition, not having outcomes relevant to our questions, or not being allocated appropriately. We obtained additional data from other published reports for Blumenthal *et al.* [39], van Dixhoorn and Duivenvoorden [8] and van Dixhoorn [40], and directly from the following authors: Blumenthal *et al.* [39] (data on anxiety and depression, 5-year follow-up); Wilk and Turkoski [35] (group sizes, SD) and van Dixhoorn [40] (2-year follow-up data). One study [19] comprised four arms that we analysed as two separate comparisons (stress management versus waiting list, and stress management with exercise against exercise alone).

Table 1 **Overview of studies, by grade of relaxation and date of publication**

Author, year	Patients			Intervention				Comparison therapy	Sample size		Design	
	Condition	Age, years (range/mean)	Recruitment	Name of treatment (components)	Group (h)	Individual (h)	Duration (weeks)		Ne	Nc	Allocation	Qual (0–4)
Brief relaxation training												
Hase and Douglas, 1987 [24]	MI	41–69	Early	Relaxation training (pmr + tape)	0	2	1–2	Usual	15	15	Bl	2
Munro *et al*., 1988 [27]	MI	52	Late	Relaxation therapy (rr + tape)	0.5	2	12	Exer	27	30	0	1
Amarosa-Tupler *et al*., 1989 [13]	AP	60	Late	Stress management (pmr + tape)	0	0.5	4	Usual + educ	10	10	Ran	3
Gallacher *et al*., 1997 [23]	AP	NS	NS	Stress management (NS + tape, cr)	3	0	10	Usual	198	209	Ran	3
Collins and Rice, 1997 [20]	MI, HS	59	Early	Relaxation intervention (pmr + tape)	0	1	6	Exer	20	23	Bl	2
Wilk and Turkoski, 2001 [35]	MI, HS, PT	52–73	Early	Progressive muscle relaxation (pmr + tape)	3.3	0	4	Exer	7	7	Ran	2
Full relaxation training												
Kavanagh *et al*., 1970 [7]	MI	<65	Late	Hypnosis (db, hyp)	50	3	52	Usual + exer	8	18	Ran (part)	2
Polackova *et al*., 1982 [30]	MI	48	Early	Autogenic training (at)	16	1	16	Usual	131	48	0	0
Bohachick, 1984 [17]	MI, HS	NS	NS	Relaxation training (pmr)	9	0	2	Exer	18	19	0	0
Baer *et al*., 1985 [15]	MI	55	Early	Stress management (pmr, db, cue)	8	1	1.14	Usual	33	37	Bl	2
Ohm, 1987 [29]	MI, HS, AP	56	Late	Relaxation training (at, pmr, cue)	9	0	6	Exer	234	186	Bl	1
Van Dixhoorn *et al*., 1990, 1998 [40,41]	MI	55	Early	Relaxation therapy (pmr, move, br, cue, emg-bfb)	0	6	6	Exer	76	80	Ran	3
Winterfeld *et al.* 1991 [36]	HS	54	NS	Konzentrative entspannung (move, br, mpr)	9	0	9	Usual	20	14	Ran	2
Winterfeld *et al*., 1993 [37]	HS	53	NS	Autogenic training (at)	14	0	14	Usual	16	14	0	0
Nelson *et al*., 1994 [28]	MI	57	Early	Stress management (pmr, move, db, cue)	8	1	1.4	Usual + educ	16	19	Bl	2
Zamarrra *et al*., 1996 [38]	MI, AP, IS	55	Late	Transcendental meditation (tm)	5	5	28	Usual	10	6	0	2
Luskin *et al*., 2002 [26]	CHF	66	Late	Stress management (hrv-bfb)	0	10	10	Usual	14	5	Ran (part)	2
Kanji *et al*., 2004 [25]	CA	63	Early	Autogenic training (at)	8	0	8	Usual	30	29	Ran	3
Del Pozo *et al*., 2004 [22]	MI, HS, PT	67	Late	Biofeedback (hrv-bfb, db)	0	4.5	6	Usual	31	32	Ran	4
Extended relaxation												
Valliant and Leith, 1986 [33]	HS	38–72	NS	Relaxation training (pmr + tape; cr)	12	0	6	Usual	19	26	0	0
Bundy *et al*., 1994 [18]	AP	54	Late	Psychological treatment (db, pmr, cue, tape; anger)	10.5	0	7	Usual	14	15	Ran	2
Turner *et al*., 1995 [32]	MI, HS	59	Late	Stress management (at; type A, anger)	14	0	1.14	Exer	18	6	Ran	3
Trzcieniecka-Green and Steptoe, 1996 [31]	MI, HS	60	Early	Stress management (at, cue, tape; irritation, time urgency)	10	0	10	Usual	50	50	Ran	2
Blumenthal *et al*., 1997 [16]	MI, HS, AP	60	Late	Stress management (pmr, emg-bfb; cr)	24	2	16	Usual	32	38	0	2
Appels *et al*., 1997 [14]	PT	55	Early	Psychological intervention (br, rr, tape; hostility)	16	0	8	Usual	30	65	0	1
Bundy *et al*., 1998 [19]	AP	56	Late	Stress management (db, pmr, cue, tape; anger)	10.5	0	7	Usual	42	16	Bl	2
Cowan *et al*., 2001 [21]	CA	NS	Late	Psychosocial nursing therapy (db, at, pmr, cue, hrv-bfb; depression, anger)	0	15	6	Educ	67	66	Ran	2

Patients condition: AP, angina pectoris; CA, cardiac arrest; CHF, congestive heart failure; HS, heart surgery; MI, myocardial infarction; PT, percutaneous transluminal coronary angioplasty. Recruitment: early, 2 months or less from index diagnosis; late, more than 2 months; NS, not stated. Intervention: Treatment components: at, autogenic training; bfb, biofeedback; br, breath relaxation; cr, cognitive restructuring procedure, cue, cue-controlled relaxation; db, deep breathing; emg, electromyographic; hrv, heart rate variability; hyp, hypnosis; move, movement, different postures; pmr, progressive muscle relaxation; rr, relaxation response. Dur, Duration of treatment; Group, training hours in group; Indiv, training hours in individual sessions. Control: educ, health education; exer, exercise training; usual, usual care; usual + educ or exer, a potentially active treatment in control group. Sample size: Nc, number of patients in control group; Ne, number of patients in experimental group. Design: Allocation: Bl, in blocks; 0, no details given; Ran, randomized. Qual, quality of study by modified Jadad score, see text for full details.

Description of included studies

Patients

Relaxation therapy was taught to inpatients of a hospital in four studies [15,24,25,28], and a rehabilitation clinic in one study [29]. The remaining studies involved outpatients. Most studies included both men and women, usually with a preponderance of men; however, two studies [16,27] included only men. The mean age of patients was between 50 and 70 years for most studies, although it was only 48 years in one [30]. Patients were recruited after MI in most studies ($n = 15$), and patients after cardiac surgery or percutaneous transluminal coronary angioplasty were included in 12; three studies included only heart surgery patients, four studies included patients with angina only, and one study included patients with congestive heart failure. One study [21] was exceptional in recruiting only patients who had experienced sudden cardiac arrest.

Ten studies [14,15,20,24,25,28,30,31,34,35] recruited patients during the rehabilitation phase directly after the cardiac event. The time of recruitment was not reported for five studies [17,23,33,36,37], and the remaining studies recruited patients more than 3 months after the qualifying event, indicating a more chronic and stable condition.

Intervention

Six studies taught patients brief relaxation (grade 1) [13,20,23,24,27,35]. In 13 studies patients were taught full, traditional relaxation, mostly including multiple techniques (grade 2) [7,15,17,22,25,26,28–30,34,36–38]. All but three [22,26,34] used a group format, and in five group instruction was complemented by individual sessions. The group hours ranged from 5 to 16 h, with a median of 9 h, but one study [7] used 50 weekly sessions. Eight studies expanded relaxation training by teaching cognitive skills [14,16,18,19,21,31–33] typically in regular weekly meetings in small groups of six to eight participants led by a psychologist (grade 3). The time spent ranged between 10 and 24 h, with a median of 11.25 h.

Control intervention

The majority of studies compared relaxation with usual care, but in seven studies [17,20,27,29,32,34,35] the control condition included exercise rehabilitation. Three studies compared relaxation with a possibly active intervention, such as education [13,28] or exercise [7].

Internal validity

The internal validity (see Table 1) was likely to be high (score 3 or 4) in six studies [13,22,23,25,32,34] moderate (score 2) in 12 studies [7,15,19–21,24,26,28,31,35,36,38] and low (score 0 or 1) in nine [14,16–18,27,29,30,33,37]. Nine studies did not report allocating all patients either by randomization or by sequential blocks [14,16,17,26,27,30,33,37,38].

Outcomes

Resting heart rate

A combined analysis of seven studies [16,20,25,26,35,37,34] (Table 2) showed a small but clear effect of a weighted mean reduction of approximately 4 bpm (95% CI 1.2–6.4 bpm). The studies are homogeneous, the funnel plot shows no asymmetry, and the difference between groups is still significant when only the four studies with moderate or good validity [20,25,34,35] are combined. Interestingly, in three of these studies both arms included exercise rehabilitation, which is known to reduce heart rate, but a separate effect of relaxation was still seen. Four studies that measured heart rate could not be included in the meta-analysis: three lacked complete data, of which two [13,36] found a positive effect. One report [7] was excluded from this analysis because the control intervention included exercise training: after 1 year of treatment both arms had similar heart rate reductions. Subgroup analysis showed that relaxation therapy grade 1 (two studies, 54 patients) was more effective than grades 2 or 3, although with overlapping confidence intervals.

Blood pressure

Ten studies [16,20,23,25–27,32,37,34,35] provide no evidence that relaxation therapy has any effect on systolic blood pressure. The one study that was positive [37] has low internal validity (no randomization or blinding) and included only 30 patients. With three studies that have high internal validity and four that are randomized, the lack of effect is robust. The four relaxation therapy grade 1 studies result in a small rise in systolic blood pressure, although statistically not significant (4.5, CI −5.6, 14.7), whereas relaxation therapy grades 2 and 3 yield a small, non-significant decrease in systolic blood pressure (−4.1, CI −8.5, 0.03).

Similarly, there is no overall effect on diastolic blood pressure. Heterogeneity is largely explained by the two studies using grade 1 relaxation therapy, but sensitivity analysis excluding them still shows no effect (−0.86, CI −3.0, 1.3, $P = 0.4$). No differential effect of grades of relaxation therapy is seen.

Exercise tolerance

Two studies [19,34] were excluded from this analysis as their control groups underwent exercise training. The remaining four studies [16,18,26,38] show a modest effect of relaxation therapy, and are homogeneous in their results and of moderate risk of bias. Two studies [18,19] (the second of which could not be combined) showed a significant difference in favour of relaxation therapy post-treatment, which had disappeared by 8 weeks follow-up. Another study [7] found the increase in mean predicted oxygen consumption to be the same with relaxation therapy as with exercise training when both were continued for 1 year. This supports the result that relaxation therapy can improve exercise tolerance, in the absence of exercise training.

Heart rate variability
Three studies [22,26,40] showed a significant effect of relaxation therapy on HRV, standardized mean difference (SMD) = 0.35 (CI 0.04, 0.65, $P < 0.03$), which increased at 3-month follow-up in two studies [22,40], SMD = 0.58 (CI 0.24, 0.93, $P < 0.0005$). All three used relaxation therapy grade 2 and were of moderate or low risk of bias.

Serum lipids
Three studies [16,23,32] found no effect of relaxation therapy on total cholesterol, WMD = 0.08 (CI 0.22, 0.06; ns). A significant increase in HDL was seen, WMD = 0.06 (CI 0.01, 0.10, $P < 0.001$), although too small to have any useful clinical impact. The studies were homogeneous, and there was no differential effect of grade of relaxation therapy.

Depression
Nine studies [14,16,17,20,23,26,30,31,33] show a moderate overall effect on depression, but the result is heterogeneous ($P < 0.00001$) as a result of two studies with clearly divergent, strongly positive, results [14,30]. Both have low internal validity. Excluding these removes both the heterogeneity and the effect (SMD −0.14, CI −0.30, 0.03; ns). Only one study has high validity [23], only two were randomized [23,31], and these two studies, with more than half the total patients ($n = 478$) showed no effect (0.10, 95% CI 0.32, −0.12). Relaxation therapy grade showed no consistent differential effect.

Anxiety
State anxiety is the outcome most commonly measured in these studies, and 13 [15–17,20,24–26,30,31,33,35,41] together show that relaxation therapy was highly significantly superior to controls, with no heterogeneity or evidence of major publication bias from the funnel plot. Eight studies have high or intermediate validity, and combining these still yields a positive result (SMD −0.28, CI −0.47, −0.10, $P = 0.003$). Selecting four studies that compared relaxation therapy in addition to exercise rehabilitation did not show a smaller effect (−0.31, CI −0.57, −0.05; $P = 0.02$). Subgroup analysis according to grade of relaxation therapy showed a smaller effect of grade 1, (−0.08, CI −0.27, 0.09) than grade 2 (−0.51, CI −0.71, −0.31), but not different from grade 3 (−0.24, CI −0.51, 0.04). One study whose data could not be included [18] found no effect on anxiety.

No effect of relaxation therapy was seen on trait anxiety in four homogeneous studies with low and moderate validity. No greater effect was seen with more intensive grades of relaxation therapy.

Frequency of angina pectoris at rest
Four studies [18,19,23,31] (of low or intermediate risk of bias) showed a statistically significant effect of relaxation therapy on angina pectoris. Statistical heterogeneity was caused by the study with the largest effect [31] in which patients were recruited after MI. After removing this study, the effect in three studies of moderate validity in angina pectoris patients is still significant (−0.34, CI −0.53, −0.15, $P = 0.0003$). The results of four studies that could not be combined [13,15,24,28] are uniformly positive. There was a clearly greater effect in four studies that used grade 3 relaxation therapy (−0.79, CI −1.07, −0.51) than the single study using grade 1 (−0.26, CI −0.48, −0.05).

Incidence of cardiac arrhythmia
The incidence of any kind of arrhythmia was reported after being extracted from medical records at discharge [24] or at 6-month follow-up [15,28]. Relaxation therapy has a significant effect, with no heterogeneity and moderate risk of bias.

Myocardial ischemia
Four studies in 255 patients measured myocardial ischaemia, but the data are too varied to be pooled. Significant differences in favour of relaxation therapy were found in wall motion abnormalities during radionuclide angiography [16], and reduced ST-depression during exercise testing [34,38]. One study [7] found the effect of relaxation therapy on ST-depression similar to that of exercise testing.

Cardiac events
Cardiac events in the first 6 months were significantly reduced in three studies [15,28,29], and the effect does not appear to diminish with time, being sustained for 1–3 years in two studies [14,21] and 3–5 years in another two [8,39]. The effect is also seen in the two studies [8,29] that compared relaxation therapy with exercise rehabilitation (odds ratio 0.54, CI 0.31, 0.94, $P = 0.03$), which is known to reduce cardiac events.

Cardiac deaths reported in four studies [8,21,28,29] for periods from 6 months to 2 years show a clear beneficial effect of relaxation therapy, although the evidence is of mixed quality. One study [39] that could not be combined showed no effect in 67 patients.

Return to work
Three homogeneous studies [28,29,34] (with validity scores 1, 2 and 3) show that the odds of being at work at 6 months after MI or coronary artery bypass graft is significantly increased by relaxation therapy.

Discussion

The main finding of this review is that the effects of relaxation therapy are manifold and extend well beyond teaching relaxation skills. Relaxation therapy can enhance recovery after a cardiac ischaemic event and encompasses all domains of rehabilitation. The clinically most relevant effects include a reduction in resting heart rate, a reduction in anxiety and in the frequency of angina pectoris, increased return to work and reduced risk of death. Most effects are complementary to exercise rehabilitation; that is, they were also present in studies in which the control treatment included exercise training. Relaxation therapy is therefore effective as an adjunct to medical care as well as standard cardiac rehabilitation. This confirms two previous reviews that established the overall contribution of stress management and psycho-education for cardiac patients [1,2], but not the specific contribution of relaxation therapy. In this review we focused on the role of relaxation therapy, and we conclude that intensive, supervised relaxation practice is an important ingredient of cardiac rehabilitation.

More specifically, relaxation therapy appears to be complementary to psycho-education, an intervention that provides patient information on risk factors and promotes healthy behaviour. Usually, it offers little skills training and no practice in the self-regulation of tension as in relaxation therapy. Psycho-education reduced risk factors such as blood pressure, cholesterol and smoking but hardly reduced anxiety, depression or angina pectoris [2]. Relaxation therapy by contrast had no benefit for these risk factors, but was beneficial for the emotional and physical state of the patient. There is thus evidence for an effect of relaxation therapy that is additional to psycho-education. This was confirmed explicitly in three studies [13,21,28], in which training in relaxation skills enhanced the effects of psycho-education.

The relationship of stress management and relaxation therapy is more complex and depends upon definition. Traditionally, stress management programmes are based upon relaxation training, and full relaxation training was seen as a form of stress management [9], because it helps individuals to deal with stress and tension. The classical relaxation methods aim to reduce the strain in the individual, which was seen to have accumulated in the course of time and exposures to stressors. In progressive muscle relaxation it is neuromuscular hypertension or elevated muscle tension [42]. In autogenic training the individual is helped to restore a disturbed psychovegetative balance [43]. Once these primary skills are learned, they are applied in daily life and the issue of stressors and how to deal with them arises. These were typically topics for the second part of full relaxation training in the studies reviewed. In modern stress management programmes, however, the main focus is the perception, appraisal and consequent coping with stressors. This cognitive–behavioural framework overlaps to a large extent with full relaxation training, which can be seen as a cognitive–behavioural treatment [44]. An important difference is the role of primary relaxation skills. Linden and colleagues [1] reviewed 23 studies with a wide array of psychological treatments, which were summarized as stress management, but only four of which contained relaxation therapy. They found an effect size for the reduction of psychological distress (anxiety and depression) and of heart rate, both $d = 0.30$, which equals the effect sizes of relaxation therapy found in this review. Psychological treatment, however, also greatly reduced cholesterol ($d = -0.95$) and to a lesser extent blood pressure ($d = -0.14$), which we could not confirm. Relaxation therapy thus does not influence risk factors like psychological treatment does, but equals the effect of psychological treatment or stress management on heart rate and anxiety.

We tried to differentiate the effects of relaxation training *per se* from relaxation training expanded with cognitive therapy. Unexpectedly, we found no evidence for the superiority of expanded treatment in cardiac patients. Similarly, in the treatment of general anxiety disorder, no differences were found in effectiveness between cognitive therapy and applied relaxation [45]. However, this is based on comparing different studies and it needs to be tested experimentally by contrasting full and expanded relaxation therapy in a single trial.

Our findings may be due to the fact that full relaxation therapy contains sufficient cognitive themes that are relevant to cardiac patients. The impact of general themes such as teaching respect for rest, the need for balance between rest and effort, the influence of mental factors on physical function, and the differentiation of cardiac causes of chest pain from stress, which are part and parcel of full relaxation therapy, may themselves be meaningful enough for most patients. Other cognitive themes such as dealing with anger, depression and time urgency may be too specific or not relevant to all participants. Another possibility may be that the practice of primary relaxation skills has a value of its own, which could have been less present in expanded relaxation therapy. Although we selected grade 3 type of studies with clear evidence of sufficient relaxation practice, the exact duration of practice was rarely specified and may have been less than in the grade 2 type of study. Therefore, the cognitive part may not have come on top but partly also instead of relaxation practice, thereby reducing its specific effects.

It needs to be emphasized that the potential equality of relaxation therapy and stress management only applies when relaxation is not taught as a simple technique in its abbreviated form. We made a point of classifying studies by the duration of relaxation training (as mastery was rarely reported), and found a clear distinction between the shortened version of relaxation therapy taught in a maximum of 3 h, and the full training format in which ample supervised relaxation practice is provided. The latter form took on average 9 h. With the exception of heart rate reduction, the effects were smaller for the abbreviated format. The effects on arrhythmia and ischaemia, as well as improved return to work and prognosis have almost exclusively been studied in full or expanded relaxation therapy.

An important limitation is that the quality of many included studies was not high. Only 10 out of 24 studies were randomized. Dusseldorp and colleagues [2] made a similar reservation, and stated that many studies use a quasi-experimental approach with different treatment assignment in different time periods, instead of random assignment, to prevent patients in the conditions interacting with each other. However, they found no systematic influence of the quality of studies on outcome. Similarly, we checked the influence of the internal validity of the studies. Only in the case of depression was the influence marked. Another limitation is the size of the studies. Many were small scale and set up as pilot studies. Only six studies recruited 100 or more patients. Nevertheless, the total number of patients added up to substantial sample sizes for the outcomes and the conclusions were statistically highly significant. However, it is important to draw only general conclusions and to be cautious with respect to effect size.

This reservation applies specifically to the effects on prognosis. The odds for future cardiac events are remarkably low after relaxation therapy. Although the total number of patients approaches 1000, it is small in comparison with trials in cardiology, and insufficient to allow a realistic estimate of probable effect size. The odds ratios for cardiac events of 0.39 and for cardiac death of 0.29 are extremely low in comparison with the reviews of psychosocial treatment, as well as with the effects of cardiac rehabilitation or beta-blockers [46,47], which are approximately 0.80. Another reason for caution is that we have no information on the mechanism for prognostic benefit. Interestingly, the finding of Dusseldorp *et al.* [2] that the long-term effect is greater in studies that were successful in reducing somatic risk factors in the short term was not corroborated, as we found very little effect on these. Nevertheless, the result does underline the role of stress in prognosis, and even more, that an increased ability for internal self-regulation of tension and stress is somehow beneficial for health. For instance, it may modify the effect of risk factors. A recent study showed that the effect of ventricular arrhythmia on prognosis was absent in those with good ability for tension regulation [48]. We need new studies not only to replicate the result and estimate effect size more accurately, but also to obtain information on the possible pathways of such an effect. It will be important to measure all the outcome variables and inter-relate them in the short term, as well as using them as predictors for long-term outcome. This review may be the starting point and rationale for such studies.

As far as implications for practice are concerned, it is of course possible to add abbreviated relaxation therapy to an exercise or lifestyle programme within cardiac rehabilitation, but the studies reviewed here allow very little success to be expected. If one wants to implement relaxation therapy, better do it well. This implies intensive supervised training in primary relaxation skills, in a separate programme, either in small groups or individually. This was done in the recent Dutch Guidelines for Cardiac Rehabilitation (2004) [49]. An independent relaxation programme was described and a multimodal approach was chosen, which requires approximately 9 h of supervised practice. Five studies in grade 2 used a multimodal approach and required on average 8 h (median 9, see Table 1). A unimodal approach such as for

Table 2 Results of meta-analyses of effects of relaxation therapy on various outcomes

Outcome	Studies	Patients	Analysis	Result (95% CI)	*P* value
Heart rate	7	381	WMD f	−3.83 (−6.43, −1.24)	0.01
Systolic BP	10	773	WMD r	−0.42 (−4.68, 3.84)	0.85
Diastolic BP	9	744	WMD r	−0.13 (−3.01, 2.75)	0.93
Exercise test	4	173	SMD f	0.44 (0.12, 0.75)	0.007
HRV	3	168	SMD r	0.35 (0.0, 0.65)	0.03
Cholesterol	3	527	WMD f	−0.08 (−0.22, 0.06)	0.3
HDL	3	527	WMD f	0.06 (0.01, 0.10)	0.008
Depression	9	957	SMD r	−0.48 (−0.88, −0.09)	0.02
State anxiety	13	1185	SMD r	−0.35 (−0.51, −0.18)	0.0001
Trait Anxiety	5	285	SMD r	−0.17 (−0.40, 0.06)	0.15
Angina pectoris	4	565	SMD r	−0.60 (−0.96, −0.23)	0.001
Arrhythmia	3	135	OR f	0.22 (0.10, 0.49)	0.0002
Cardiac events (<1 year)	3	475	OR f	0.44 (0.23, 0.83)	0.01
Cardiac events, total	7	916	OR f	0.39 (0.27, 0.57)	0.001
Cardiac deaths (2 years)	4	694	OR f	0.29 (0.12, 0.70)	0.006
Return to work	3	376	OR f	1.83 (1.18, 2.81)	0.006

BP, Blood pressure; CI, confidence interval; f, fixed effects; HDL, high-density lipoprotein cholesterol; HRV, heart rate variability; OR, odds ratio; r, random effects; SMD, standardized mean difference; WMD, weighted mean difference.

instance autogenic training requires extended practice. The five studies that used a cognitive unimodal relaxation format took on average 19.5 h of practice (median 14). It is thus recommended to offer techniques for attention control, for muscle relaxation, for breath regulation and for posture and small movements. Furthermore, it is recommended to offer this wide array of technique modalities and have each patient find out which modality suits best and produces the most concrete changes in tension. It is thus essential to assess mastery. Few studies provided information on whether patients actually learned the primary skills of relaxation. It is not easy to establish, because there is no single measurement for relaxation success, but effort should be made to estimate the degree of mastery. For implementation it is important to ensure adequate training of the teaching staff and therapists. There is a lack of information on this aspect in the studies reviewed, but this is crucial to implementation. Possibly, studies have been undertaken mostly by individual researchers who acquired expertise and experience in relaxation skills by personal preference. As the ability to conduct full relaxation therapy is not provided in any healthcare professional education, the development of treatment protocols and staff training requires careful planning and preparation.

To conclude, this review shows evidence that supports the utility of supervised relaxation practice as a treatment *per se* and warrants the inclusion of full relaxation therapy in cardiac rehabilitation, because it enhances recovery from an ischaemic event and it contributes to secondary prevention, independently of the effect of psychoeducation and of exercise.

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