PROMOTING PATIENT UTILIZATION OF CARDIAC REHABILITATION – SYSTEMATIC REVIEW AND KNOWLEDGE TRANSLATION

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A DISSERTATION SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

GRADUATE PROGRAM IN KINESIOLOGY AND HEALTH SCIENCE
YORK UNIVERSITY
TORONTO, ONTARIO

January 2020

ABSTRACT

Cardiac Rehabilitation (CR) is a proven, cost-effective outpatient model of care for secondary prevention of cardiovascular disease (CVD), a highly prevalent health condition worldwide. Unfortunately, despite the existence of some guidelines with recommendations to refer CVD patients to CR, rates of CR utilization are low. Lack of supportive and robust endorsement by a healthcare provider may serve as a barrier to utilization. The overall aim of the doctoral dissertation is to advance scholarly understanding and knowledge translation to promote CR utilization. For this purpose, three interlinked research studies were undertaken. Using rigorous Cochrane's methodological standards, I first updated the Cochrane systematic review on interventions to promote patient utilization of CR. Next, the first-ever position statement on implementable recommendations to increase patient utilization of CR was developed in accordance with AGREE II, among other guideline checklists, to build on the findings of the updated systematic review. Finally, following Kirkpatrick's framework in a multi-method study, an online course for healthcare providers was developed and tested to promote the implementation of the recommendations gained from the earlier work. The present dissertation is fundamental in the identification and knowledge transfer of effective interventions to promote patient utilization of CR programs. The recommendations and tools developed herein will potentially guide policy-makers, healthcare providers and cardiac patients towards greater utilization of CR and therefore, reduction of CVD risk.

Keywords: coronary artery disease; secondary prevention; health services accessibility; cardiac rehabilitation; patient participation, professional education

ACKNOWLEDGEMENTS

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change." *Charles Darwin*

This dissertation is dedicated to loved ones and mentors who have been present throughout this entire journey, and those who had to leave before the end, you will forever be in my heart. Thank you for your unyielding love, support, and encouragement that have enriched my spirit and inspired me to become someone that can genuinely make a difference in this world.

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CHAPTER ONE: GENERAL INTRODUCTION

Cardiac Rehabilitation (CR) is a proven, cost-effective outpatient model of care for secondary prevention of cardiovascular disease (CVD), a highly prevalent health condition worldwide. The benefits of CR include improvements in exercise capacity, reduction of coronary risk factors associated with disease development, improvement of psychosocial well-being and quality of life, as well as reductions in morbidity and mortality[1,2].

The Cochrane Collaboration is an international organization that produces and disseminates systematic reviews of healthcare interventions. In the most recent Cochrane review, CR was shown to result in a 26% reduction in CV mortality and an 18% reduction in re-hospitalization[3]. As a result, CR referral is an integral recommendation in most clinical practice guidelines for secondary prevention in cardiac patients[2,4,5,6].

Unfortunately, despite the existence of guidelines for healthcare providers with recommendations to refer CVD patients to CR[7], rates of CR utilization are low. There is a Cochrane review on interventions to promote utilization of CR; 18 studies were included in the last update of 2013[8]. The identified successful interventions included structured nurse-or therapist-led contacts, early appointments after discharge, motivational letters, gender-specific programs, and intermediate phase programs for older patients[8]. Since the publication of the 2014 review, several more studies have examined CR utilization. In the early stages of the dissertation, the need to update the review was recognized along with the need to expand the focus from "uptake" to enrollment, adherence and completion.

Given the importance of the current guidance on updating systematic reviews[9], through this dissertation, the review on interventions to promote utilization was updated. This was followed by incorporation of the findings into a position statement, and the development of an online course for healthcare providers to promote implementation of the recommendations and testing of the utility of the tool to increase utilization of CR. The dissertation is organized in five chapters. Chapter 1 presents a focused literature review followed by specific objectives of the three studies undertaken. Chapter 2 presents results from the published systematic review entitled "Interventions to promote patient utilization of cardiac rehabilitation." Chapter 3 presents a paper entitled "Promoting patient utilization of outpatient cardiac rehabilitation: A joint International Council and Canadian Association of Cardiovascular Prevention and Rehabilitation position statement." Chapter 4 presents the development and testing of an online course for healthcare providers and is under-review in the BMC Health Services Research. The concluding chapter makes additional recommendations for policy, practice and research.

Literature Review

CVDs are disorders of the heart and blood vessels, such as coronary artery disease and stroke, among others. The burden of CVD remains substantial, and the World Health Organization lists CVD as the number one cause of mortality and morbidity worldwide[10]. In 2016, there were 422.7 million CVD cases globally[11]. In Canada, 6% of the population in 2014 reported living with a CVD and this risk increases with higher age and lower household income[12]. In low and middle-income countries, CVD burden is substantial, causing high disability rates[13]. CVD represents a major economic burden on healthcare systems causing direct and indirect costs along with societal costs, such as loss of human productivity and healthy

citizenship due to disability. In this context, there is increasing recognition of the need to deliver comprehensive, multidimensional secondary prevention approaches to prevent recurrent CVD events and optimize quality of life[14].

CR is a medically-sponsored program offered to individuals to aid recovery and prevent further cardiac events. It includes specific core components such as initial assessment, structured exercise, comprehensive education and counselling. CR is designed to optimize CV risk reduction, foster healthy behaviours (e.g., exercise, healthy eating, smoking cessation), increase patient's understanding of their disease and improve psychosocial well-being[15,16,17]. On average, CR programs globally offer 3 sessions per week over 5 months[18]. Moreover, evidence clearly shows that the more sessions patients attend, the better their outcomes and the lower their risk for heart attack and mortality compared with those who do not participate[19–24].

In the Cochrane reviews on CR, sensitivity analyses examining dose of CR were performed, first in 2004[25], and again in 2011[26] and 2016[3] updates. CR dose was operationalized by multiplying the number of weeks of exercise (i.e., program duration) by the number of training sessions per week (i.e., frequency) and by the average duration of exercise sessions in minutes (personal communication). Dose was then stratified as ≤ vs > 1,000 "units". No associations between dose and outcomes were observed in the first 2 meta-analyses, but in the most recent one, patients who had ≥1,000 'units' had 25% lower CV mortality and 26% lower myocardial infarction (MI). Similarly, in the meta-analysis by Lawler et al [27], patients exposed to a higher dose of CR, in this case a program of ≥3 months duration, had significantly lower CV mortality and MI, but not all-cause mortality.

Once patients are referred to a CR program, they need to enroll. Enrolment is defined as patient attendance at a first CR program visit[28]. After CR program initiation, patients are expected to adhere to the program in order to achieve the benefits by attending all or at least some of their prescribed CR sessions. Adherence is defined as the proportion of prescribed sessions attended. Completion is defined as the percentage of patients enrolled in CR who attended at least some of the CR intervention components and had a formal re-assessment by the CR team[29].

Cardiac rehabilitation under-utilization

Although the beneficial effects of CR have been proven, enrolment, adherence and completion is grossly suboptimal. Additionally, given the positive association between CR and patient outcomes, it is key to promote greater CR utilization. For the purpose of this dissertation, utilization will be defined as enrolment, adherence and/or completion of CR services. Each of the 3 key elements of utilization are examined in detail below.

Enrolment

Once referred, patients need to enroll in CR. In Canada, there is a recommended target of 70% enrolment[28]. Rates of enrolment would vary by country based on differences in healthcare systems (e.g., availability of CR and how it is funded), and there is a dearth of available population-based data on enrolment rates, and this includes Canada. In Ontario, according to a prospective multi-site study, only 37% of referred patients ultimately enrolled[30]. A population-based study in The Netherlands reported that only 30.7% of patients started CR within the first 180 days after the cardiac event or procedure[31]. A recent cohort study in the United States showed enrolment rates of 16.3% in Medicare users post-MI, percutaneous coronary intervention

(PCI) or coronary artery bypass graft surgery (CABG)[32]. Another large cohort study in the United States found that only 14% of patients after a MI and 31% after a coronary artery bypass graft enroll in CR[33]. A meta-analysis on enrolment rates in women and men reported enrolment rates in included studies ranged from 7.1% to 73.0%[34].

Adherence

As outlined above, evidence clearly shows that the more sessions patients attend, the better their outcomes and the lower their risk for heart attack and mortality compared with those who do not participate[19–24]. Large population-based studies examining adherence rates of CR sessions are limited, and only data from smaller studies are available; additionally rates of adherence vary widely by countries. A cohort study conducted in the United States included Medicare beneficiaries and reported that more than 40% of included patients attended ≥30 sessions out of 36 and 13% of included participants attended <6 of prescribed sessions out of 36[20]. Another study in the United States included 4412 participants and reported 51% session adherence out of 36 sessions[35]. However, a study conducted in Latin America reported lower adherence rates, overall, 33% out of 36 sessions[36]. A meta-analysis examining sex-differences in adherence reported overall adherence rates of 66.5 ± 18.2% (median 72) of prescribed CR sessions across included studies[37]. Reviews examining adherence rates in the overall cardiac population are needed.

Completion

CR is considered to be completed where patients attend at least some of their prescribed sessions, and also that they undergo a formal patient re-assessment where any remaining uncontrolled risk factors would be identified and hence managed. There is a transition process to ensure continuity of care and patient self-management long-term. A large cohort study of

individuals with CVD and diabetes in Canada demonstrated that completion of CR was associated with significant reductions in mortality and cardiac rehospitalization[38]. It is suggested that rates of adherence globally are low and the percentage of patients failing to complete the program (drop-outs) is high. Data from European countries report a 20% drop-out rate during CR[39]. However, data from the United Kingdom CR registry reported that of those who enrol, completion rates can be high (77%); however this data captures only a select group of patients (following a MI, PCI and CABG) within the UK[40].

Utilization barriers

The reasons behind limited utilization in CR programs are multifactorial and well-established and include factors at the health system, referring provider, program and patient-level challenges[41,42,43]. Andersen's Behavioral Model of Healthcare Utilization can be applied for CR utilization[44]. It is a theory used to identify and consider both individual and contextual determinants of health services and healthcare utilization. The objective of the model is to identify circumstances that may either facilitate or impede healthcare utilization, therefore impacting medical care access and patients' differing levels of use. The multi-level model (see Figure 1) posits that there are three groups of predictors for healthcare utilization: predisposing, enabling and need factors. The predisposing factors are characteristics that influence one's predisposition to use a healthcare resource, such as age, sex, ethnocultural background, work status, level of education, occupation, family income, health beliefs, attitudes and values. The enabling factors are ones that influence an individual's decision to use a healthcare resource, such as financial means to pay for healthcare services, marital status, availability of healthcare facilities, means of transportation, travel time, wait time and health insurance coverage. The

need factors examine the health and functional status of an individual and its effect on the use of healthcare resources, such as perceived need for health services, healthcare personnel assessment of patients' health status and overall measures of community health.

Several factors may impact CR utilization. Studies investigating moderators and barriers to CR utilization have revealed factors at each of the levels of Anderson's model. With regard to the predisposing factors, women are less likely to utilize CR services than men, also older patients with comorbidities, lower socioeconomic status, lack of perceived need due to CVD severity minimization, lack of information or familiarity with the nature of CR programs, lack of knowledge of CR locations and program benefits[41,45–50]. The enabling factors include travel-related barriers, lack of insurance coverage or reimbursement, lack of availability of CR programs in the area and work-time conflicts such as house and care-giving responsibilities[47,50–53]. With regard to the need factors, lack of strong and supportive endorsement by a healthcare provider and lack of social or family support may also serve as barriers to utilization[41,46,47,50].

Equity and CR utilization

Equity is defined by the World Health organization as the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically or geographically[54]. As mentioned above, healthcare utilization is a multifaceted process, depending on availability, affordability and accessibility. Regarding CR utilization, equity could be evaluated as the proportion of participants in a certain under-represented group utilizing CR services, or specific interventions to increase CR utilization from under-represented groups, such as women, ethnocultural minorities, and patients of low socioeconomic status who are older, rural, or complex (e.g. multiple indications, comorbidities).

Strategies to increase cardiac rehabilitation utilization

Interventions to increase CR utilization have been developed and tested, with mixed success. The literature on interventions to increase CR utilization has been critically reviewed and synthesized. The first review was published in 2004[55], updated in 2005[56], and the following updates were carried out by the Cochrane Collaboration in 2010[57] and 2014[8]. The reviews identified some evidence that interventions to increase enrolment in CR can be effective; however, there is insufficient evidence to provide recommendations on interventions to increase adherence/completion. Unfortunately, there was insufficient homogeneity to pool analyses quantitatively.

Specifically, the most recent review of 2014 identified 10 trials of interventions to improve CR enrolment, eight studies were effective, and they included: structured nurse- or therapist-led contacts[58,59,60,61], early appointments after discharge[62], motivational letters[63], gender-specific programs[64], and intermediate phase programs for older patients[65]. Eight studies were identified to increase program adherence, only three studies reported improvement on adherence. They used self-monitoring of activity monitoring with daily diary entries, tailored counseling by CR staff, goal setting, and action planning[66,67,68]. Novel interventions such as self-management and gender-tailored programs to improve enrolment in under-represented groups like women and older participants were found to be effective as well[64,65].

RATIONALE

Recently, consensus guidance has been developed regarding when and how to update reviews[69]. The 2014 Cochrane review meets the criteria for updating established by Garner et al. in 2016, as (1) it still addresses a current question of importance for healthcare professionals, and the public, and (2) recent studies have been published reporting on CR enrolment, adherence and completion interventions[70,71,72] - therefore, novel information might arise.

In addition, since publication of the 2014 review, review methods have evolved[73,74]. With regard to the latter, the Methodological Expectations of Cochrane Intervention Reviews (MECIR) has been published[73]. The 2014 did not conform to these standards in several ways. the Grading of Recommendations, Assessment, Development and Evaluation (GRADE)[75] approach was not used, and no summary of findings table was developed. These approaches evaluate the quality of evidence and the strength of recommendations from systematic reviews. In addition to providing a summary of the results, a summary of findings table provides crucial information about the interpretation of the quality of the evidence and magnitude of effect[73].

The protocol itself has not been substantively updated through each iteration of the review. There are 4 main ways that the population, intervention, comparator, outcomes (PICO)[72] for the review could be improved. There is now more evidence that CR benefits patients with rhythm disorders, heart transplants, heart valve procedures and implantable defibrilators[76,77]. These indications were previously excluded. Second, interventions to promote utilization of specific elements (i.e. enrolment, adherence or completion) of a CR program were considered (except pharmacotherapy), whereas current practice is for CR to be a comprehensive program comprised of all core components (i.e. not just the exercise component). Therefore, it is

important that interventions to increase utilization of programs only be considered. Third, more specific operationalization of "uptake" is warranted to better differentiate between enrolment (formerly termed "uptake"), adherence and completion. This may have the ancillary benefit of gaining sufficient homogeneity to allow meta-analysis. Finally, MECIR recognizes the importance of equity. Interventions aimed to increase utilization in marginalized groups (women, ethnocultural minorities, low socioeconomic status, older, rural and complex patients) should be included as an outcome. Given this broadened scope of outcomes, the focus on the impact of interventions on reducing mortality and morbidity was not included in this review. It was perceived that the Cochrane review demonstrating the impact of CR itself on these outcomes[3] would suggest that interventions to increase CR utilization would result in those benefits.

At the same time, development of a review is insufficient to change practice and to achieve greater utilization; the interventions identified must be implemented. The process of knowledge translation (KT) is defined by the Canadian Institutes for Health Research, as the "dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve health, provide more effective health services and products, and strengthen the healthcare system"[78]. The inspiration to inform practice, led to my interest in the development of an evidence-based position statement that could be endorsed by multiple professional bodies locally and internationally.

Evidence-based guidelines and position statements (i.e., a position statement is an evidence-based document with a narrower scope than clinical practice guidelines) are systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances. Guidelines and position statements can play an

important role in health policy formation and healthcare promotion[79]. To our knowledge, there are no other guidelines or position statements that are evidence-based which address how to increase CR utilization. Published CR guidelines in Canada[2], the United States[4] and Europe[15] cover this topic but they are narrative guidelines, not based on a rigorous literature review and do not consider the strengths and limitations of the body of evidence, nor provide recommendation or tools (e.g. courses, workshops, handouts and so forth) to facilitate the recommendations into practice.

Further, a successful presentation of practice-recommendations into routine clinical practice involves thoughtful development, dissemination and implementation of tools (e.g. documents, workshops and courses)[80,81]. Such KT process should follow established strategies sensitive to various settings by taking contextual barriers into consideration[82], an area that led to my doctoral work on the development of a guideline tool, namely an online course for healthcare providers on CR utilization. It is understood that practice-recommendations do not flow automatically from a practice guideline developed by professional bodies, but a concerted KT initiative is needed for their dissemination to the public, to patients and to professionals[83].

OBJECTIVES

In light of the literature review and scholarly understanding discussed above, the doctoral dissertation comprised of three interlinked studies.

Study #1 – Cochrane Systematic Review on Interventions to Promote Patient Utilization of CR.

The purpose of this study was to undertake an updated systematic review and meta-analysis, applying current Cochrane methodological standards, of interventions to increase

patient enrolment, adherence, and completion of CR, as well as to consider equity, costs, and harms.

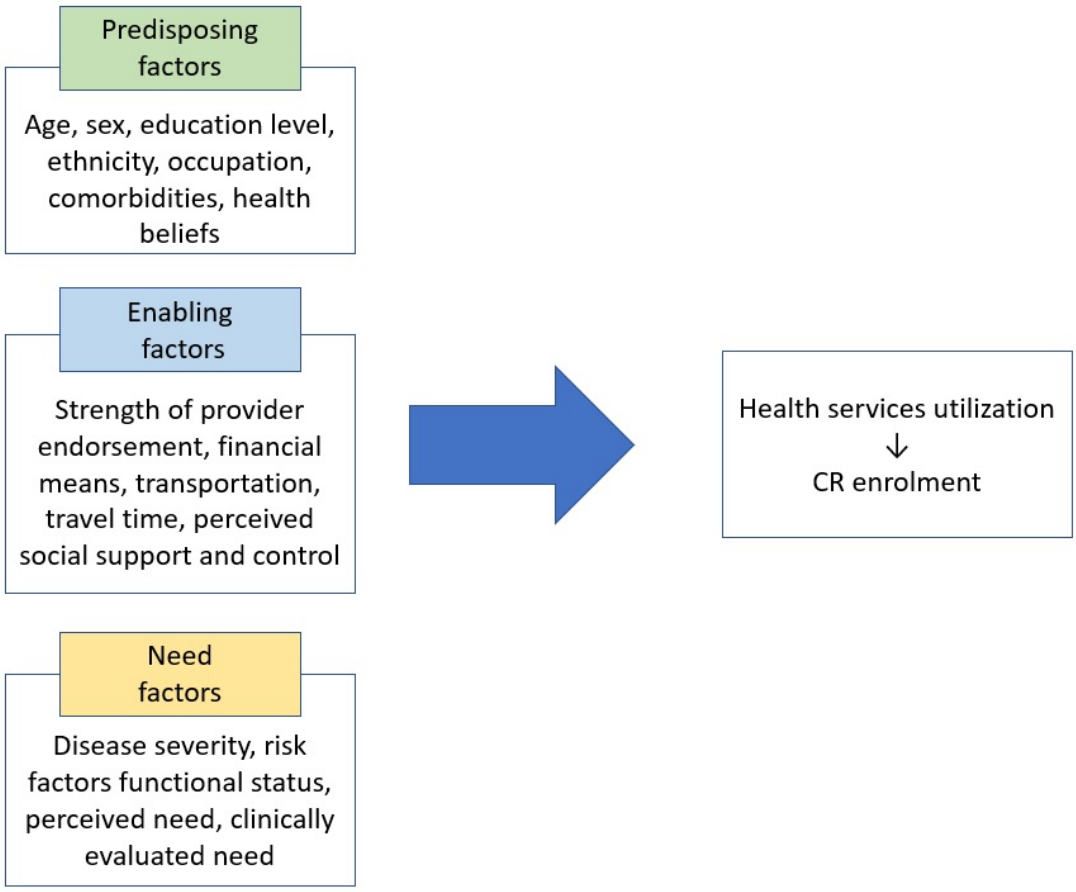
Study #2 –Promoting Patient Utilization of Outpatient CR Position Statement.

The objectives of this study were to: (1) develop evidence-based recommendations on interventions to increase patient enrolment in, adherence to and completion of CR.

Study #3 – Implementation of Recommendations for Inpatient Healthcare Providers' Encouragement of CR Participation: Development and Evaluation of an Online Course

The objectives of this study were to: (1) describe the needs assessment, implementation tool development process, and evaluation of its' efficacy, with regard to learner knowledge, attitudes, self-efficacy, and practice.

Figure 1. Behavioral model of health service use for cardiac rehabilitation



CR, Cardiac Rehabilitation

CHAPTER 2

Interventions to promote patient utilization of cardiac rehabilitation

CHAPTER 2: STUDY 1

CERTIFICATE OF AUTHENTIFICATION

Santiago de A. Pio, C., Chaves, G.S., Davies, P., Taylor, R.S. & Grace, S.L. (2019). Interventions to promote patient utilisation of cardiac rehabilitation. Cochrane Database Syst Rev; Issue 2; Art. No.: CD007131. Doi: 10.1102/14651858.CD007131.pub4. February.

Author	Contribution
Santiago de A. Pio, C.	- conducting the literature review update/study selection (50%) - handsearching the literature (100%) - extracting data from included studies (50%) - performing meta-analysis of data (50%) - conducting risk of bias and GRADE assessments (100%) - generating the 'Summary of findings' table (100%) - updating review results (text and display items) (100%)
Chaves, G.S	- conducting the literature review update/study selection (50%) - extracting data, assessing risk of bias (50%) - performing initial analysis of data (50%)
Davies, P.	- undertook previous versions of the review (50%) - reviewing GRADE ratings (100%) - critically revising the manuscript for important intellectual content (50%) - providing final approval of the review (100%)
Taylor, R.S.	- oversaw previous versions of the review (50%) - performing meta-regression analysis (100%) - critically revising the manuscript for important intellectual content (50%) - providing final approval of the review (100%)
Grace, S.L.	- co-ordinating the update (100%) - updating study protocol (100%)

	- resolving abstract and full-text conflicts (100%) - assisting in interpretation of data (100%) - updating the review content text (100%) - providing final approval of the review (100%)

Interventions to Promote Patient Utilization of Cardiac Rehabilitation

ABSTRACT

Background: International clinical practice guidelines routinely recommend that cardiac patients participate in rehabilitation programmes for comprehensive secondary prevention. However, data show that only a small proportion of these patients utilize rehabilitation.

Objectives: First, to assess interventions provided to increase patient enrolment in, adherence to, and completion of cardiac rehabilitation. Second, to assess intervention costs and associated harms, as well as interventions intended to promote equitable CR utilization in vulnerable patient subpopulations.

Search methods: Review authors performed a search on 10 July 2018, to identify studies published since publication of the previous systematic review. We searched the Cochrane Central Register of Controlled Trials (CENTRAL); the National Health Service (NHS) Centre for Reviews and Dissemination (CRD) databases (Health Technology Assessment (HTA) and Database of Abstracts of Reviews of Effects (DARE)), in the Cochrane Library (Wiley); MEDLINE (Ovid); Embase (Elsevier); the Cumulative Index toNursing and AlliedHealth Literature (CINAHL) (EBSCOhost); and Conference Proceedings Citation Index - Science (CPCI-S) on Web of Science (Clarivate Analytics). We checked the reference lists of relevant systematic reviews for additional studies and also searched two clinical trial registers. We applied no language restrictions.

Selection criteria: We included randomized controlled trials (RCTs) in adults with myocardial infarction, with angina, undergoing coronary artery bypass graft surgery or percutaneous coronary intervention, or with heart failure who were eligible for cardiac rehabilitation.

Interventions had to aim to increase utilization of comprehensive phase II cardiac rehabilitation. We included only studies that measured one or more of our primary outcomes. Secondary outcomes were harms and costs, and we focused on equity.

Data collection and analysis: Two review authors independently screened the titles and abstracts of all identified references for eligibility, and we obtained full papers of potentially relevant trials. Two review authors independently considered these trials for inclusion, assessed included studies for risk of bias, and extracted trial data independently. We resolved disagreements through consultation with a third review author. We performed random-effects meta-regression for each outcome and explored prespecified study characteristics.

Main results: Overall, we included 26 studies with 5299 participants (29 comparisons). Participants were primarily male (64.2%). Ten (38.5%) studies included patients with heart failure. We assessed most studies as having low or unclear risk of bias. Sixteen studies (3164 participants) reported interventions to improve enrolment in cardiac rehabilitation, 11 studies (2319 participants) reported interventions to improve adherence to cardiac rehabilitation, and seven studies (1567 participants) reported interventions to increase programme completion. Researchers tested a variety of interventions to increase utilization of cardiac rehabilitation. In many studies, this consisted of contacts made by a healthcare provider during or shortly after an acute care hospitalization.

Low-quality evidence shows an effect of interventions on increasing programme enrolment (19 comparisons; risk ratio (RR) 1.27, 95% confidence interval (CI) 1.13 to 1.42). Meta-regression revealed that the intervention deliverer (nurse or allied healthcare provider; P =0.02) and the delivery format (face-to-face; P = 0.01) were influential in increasing enrolment.

Low-quality evidence shows interventions to increase adherence were effective (nine comparisons; standardised mean difference (SMD) 0.38, 95% CI 0.20 to 0.55), particularly when they were delivered remotely, such as in home-based programs (SMD 0.56, 95% CI 0.37 to 0.76). Moderate-quality evidence shows interventions to increase programme completion were also effective (eight comparisons; RR 1.13, 95%CI 1.02 to 1.25), but those applied in multi-centre studies were less effective than those given in single-centre studies, leading to questions regarding generalizability. A moderate level of statistical heterogeneity across intervention studies reflects heterogeneity in intervention approaches. There was no evidence of small-study bias for enrolment (insufficient studies to test for this in the other outcomes).

With regard to secondary outcomes, no studies reported on harms associated with the interventions. Only two studies reported costs. In terms of equity, trialists tested interventions designed to improve utilization among women and older patients. Evidence is insufficient for quantitative assessment of whether women-tailored programmes were associated with increased utilization, and studies that assess motivating women are needed. For older participants, again while quantitative assessment could not be undertaken, peer navigation may improve enrolment. **Conclusions:** Interventions may increase cardiac rehabilitation enrolment, adherence and completion; however the quality of evidence was low to moderate due to heterogeneity of the interventions used, among other factors. Effects on enrolment were larger in studies targeting healthcare providers, training nurses, or allied healthcare providers to intervene face-to-face; effects on adherence were larger in studies that tested remote interventions. More research is needed, particularly to discover the best ways to increase programme completion.

INTRODUCTION

Description of the condition

The burden of cardiovascular disease (CVD) is substantial, and it is the number one cause of death worldwide[84]. Advances in therapeutic procedures and pharmacological therapies have led to dramatic reductions in CVD mortality; as a result, greater numbers of men and women survive acute CVD events and are living with this condition chronically. In this context, there is increasing recognition of the need to build comprehensive, multi-dimensional prevention approaches to prevent recurrent CVD events and to optimize quality of life.

Description of the intervention

Cardiac rehabilitation (CR) refers to the "coordinated sum of activities required to influence favourably the underlying cause of CVD, as well as to provide the best possible physical, mental, and social conditions, so that the patients may, by their own efforts, preserve or resume optimal functioning in their community and, through improved health behaviour, slow or reverse progression of disease"[85]. CR includes specific core components that aim to optimize cardiovascular risk reduction, foster healthy behaviours (e.g. exercise, healthy eating, no smoking), increase patients' understanding of their disease, and improve psychosocial well-being[15,86]. This review evaluates interventions that promote utilization of a comprehensive phase II (i.e. post-acute care) CR programme. On average, patients attend a programme two times a week over five months[87].

How the intervention might work

CR has been shown to improve quality of life, as well as to decrease subsequent morbidity and mortality[3]. As a result, CR is an integral recommendation in many national guidelines for secondary prevention in cardiac patients [88–95]. By promoting utilization of CR, clinicians can help patients achieve the benefits of participation; the more patients participate, the better are their outcomes[20,21,24,87,96].

Why it is important to do this review

Although beneficial effects of CR have been shown, utilization remains suboptimal. Surveys across several countries have shown that only approximately 30% of eligible patients participate in such programmes[32,97–99]. Such under-utilization can be attributed in part to low referral rates among healthcare providers[100].

However, even among individuals referred to CR, few enrol in the programme, and many of those who do, drop out[37,101,102]. Factors impacting utilization of CR include logistical factors (e.g. distance, financial constraints), intrapersonal factors (e.g. gender, age, depression), interpersonal factors (e.g. social support, work obligations), programme factors (e.g. time of delivery), and healthcare system factors (e.g. lack of referral, cost)[103,104]. This review was originally published in 2005[105]; it was updated via Cochrane methods in 2010[106], and again in 2014[8].

This Review has identified some evidence to show that interventions to increase enrolment (termed “uptake” in previous versions) in CR can be effective but has found insufficient evidence to provide recommendations on interventions to increase adherence.

Review authors did not specifically consider programme completion. Since the time the review was published, several new trials have been completed, and these results could potentially be pooled quantitatively to more rigorously test the effects of these utilization interventions. In this review, we aimed to update the 2014 review by incorporating and analysing the most recent additions to the literature.

Objectives

First, to assess interventions provided to increase patient enrolment in, adherence to, and completion of CR. Second, to assess intervention costs and associated harms, as well as interventions intended to promote equitable CR utilization in patient subpopulations.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomized or quasi-randomized controlled trials (RCTs) at the individual or cluster level, of parallel-group or crossover design.

Types of participants

We included adults (age 18 years or over) with MI, with angina, following coronary artery bypass graft (CABG) surgery or percutaneous coronary intervention (PCI), or with heart failure (HF) who were eligible for CR (inpatient or outpatient setting). For studies for which only part of the sample would be considered eligible based on the criteria for this review, we

contacted the corresponding author to request findings in the eligible subsample. For studies of interventions to increase adherence or completion, participants were those who had already enrolled to take part in a CR programme at the start of the study.

Types of interventions

We included any intervention with the specific aim of increasing patient enrolment in, adherence to, or completion of CR. For the purposes of this review, we defined CR programmes as those that offer (1) initial patient assessment, (2) prescribed, structured exercise, and (3) at least one other strategy to control CV risk factors (i.e. comprehensive CR). Interventions could be targeted to individuals, groups, partners, caregivers or other family members, or healthcare professionals. We excluded studies evaluating the effects of interventions to improve exercise behaviour or utilization of pharmacological treatments alone (i.e. not in conjunction with any other CR components). Comparison arm participants had to be given an equivalent opportunity to attend a CR programme. Studies of adherence or completion had to offer a comparable CR programme in the comparison arm.

Types of outcome measures

Primary outcomes

Primary utilization outcome measures for this review included:

- enrolment (formerly termed “uptake”) in a CR programme, which we defined as participant attendance at a first visit (dichotomous, yes/no);
- adherence to CR, defined as percentage of total prescribed sessions completed; and

• completion, whereby participants attended at least some of the CR intervention components and underwent formal reassessment by the CR team at the conclusion of the programme (dichotomous, yes/no).

When researchers assessed a utilization indicator but did not operationalize it in accordance with the definitions herein, we considered the article eligible for quantitative pooling. We did not consider measures such as exercise capacity (strength, peak oxygen uptake), as they do not give an indication of the extent to which participants adhered to the overall programme (just exercise). Length of follow-up is a consideration only for studies of enrolment, as adherence and completion can be assessed only at programme end (regardless of programme duration, but this was considered in subgroup analysis). For studies in which researchers ascertained enrolment at more than one follow-up point, we included the longest follow-up at which all participants were included.

Secondary outcomes

Secondary outcomes were:

• harms or adverse events related to the intervention;

• costs (i.e. costs of implementing the intervention, or costs of avoiding healthcare as a result of the intervention); and

• equity (i.e. intervention provided to increase utilization in under-represented groups such as women, ethnocultural minorities, and patients of low socioeconomic status who are older, rural, or complex (e.g. multiple indications, comorbidities)). Equity could be operationalized as the proportion of participants in a certain under-represented group utilizing CR, or studies could include only participants from under-represented groups and could compare the impact

of an intervention on utilization versus usual CR care. We included only studies that measured at least one primary outcome.

Search methods for identification of studies

We used a generic search strategy, as this review forms part of the broader set of Cochrane reviews regarding CR[3,16,107–109] and we applied detailed search strategies for each electronic database searched.

Electronic searches

We adapted and updated search terms from the 2014 Cochrane review[8], and we searched the following databases on 10 July 2018.

• Cochrane Central Register of Controlled Trials (CENTRAL), in the Cochrane Library (Wiley), July 2018.

• Database of Abstracts of Reviews of Effects (DARE; Issue 2 of 4), in the Cochrane Library (Wiley), April 2015.

• Health Technology Assessment Database (HTAD; Issue 4 of 4), in the Cochrane Library (Wiley), October 2016.

• MEDLINE Ovid, 1946 to 10 July 2018; MEDLINE In-Process & Other Non-Indexed Citations Ovid, 10 July 2018; MEDLINE(R) Epub Ahead of Print Ovid, 10 July 2018.

• Embase, 1974 to 9 July 2018; Embase Classic, 1947 to 1973.

• Cumulative Index to Nursing and Allied Health Literature (CINAHL), with full text (EBSCOhost), 1981 to present.

• Conference Proceedings Citation Index - Science (CPCI-S) (Web of Science, Clarivate Analytics), 1900 to 9 July 2018.

We applied search filters to several databases in an attempt to limit retrieval to RCTs. For MEDLINE, we applied the Cochrane highly sensitive search filter, sensitivity-maximising version[110]. For Embase, we translated from Ovid to embase.com syntax the multi-term Embase filter with the best balance of sensitivity and specificity[111], and we limited the search to records indexed in Embase. For CINAHL, we used the McMaster highly sensitive filter for retrieving RCTs[112]. For the Conference Proceedings Citation Index - Science, we used a combination of terms to identify trials described in Section 6.3.2.2, of the *Cochrane Handbook for Systematic Reviews of Interventions*[110].

For this update, we limited retrieval by entry date, from 2013 to the search date, for MEDLINE, Embase, and CINAHL. We limited retrieval by publication date, from 2013 to the search date, for Web of Science and the Cochrane Library. We did not employ any RCT filters or date limits to Ovid MEDLINE In-Process or Epub Ahead of Print databases. We imposed no language or other limitations. We considered variations in terms used and in spellings of terms in different countries, so studies were not missed by the search strategy. See Appendix 1 for the search strategy employed in this update.

Searching other resources

We hand searched the reference lists from other identified publications for potentially relevant articles (e.g. systematic review and meta-analysis, such as Matata 2017[113]). We asked the main authors of studies and experts in this field for any missed, unreported, or ongoing trials. If study articles fit review eligibility criteria, we considered them for inclusion. We searched

clinical trial registers (Clinicaltrials.gov - www.clinicaltrials.gov; and the World Health Organization (WHO) International Clinical Trials Registry platform - http://www.who.int/ictrp/en/) on 10 July 2018. We used the search terms “enrolment”, “adherence”, “completion”, “compliance”, “uptake”, “cardiac rehabilitation”, “physiotherapy”, “coronary artery disease”, and “heart disease”, among others, to identify recent and ongoing trials. Based on changes to inclusion and exclusion criteria, we re-considered studies that had been included, excluded, and ongoing in the previous review for inclusion in this present review.

Data collection and analysis

Selection of studies

At least two review authors (CP, GC) independently screened references identified through the search strategy. To be selected, abstracts had to identify the study design clearly, an appropriate population, and a relevant intervention. We excluded clearly irrelevant references. We obtained the full-text reports of potentially eligible trials, and two review authors (CP, GC) independently assessed them for eligibility, based on the criteria defined above. We resolved disagreements by discussion or, when we could not reach agreement, by consultation with an independent third review author (SG). We undertook this in Covidence[113].

Data extraction and management

For this update, we developed an updated data extraction form based on the one developed for the previous review, the Cochrane Heart Group template for RCTs, and amendments to the methods for this updated review. We built this into Covidence. Two review authors (CP,GC) independently extracted relevant data characterising study design, participants,

intervention features, risk of bias, and results. We resolved disagreements by discussion or, when we could not reach agreement, by consultation with a third review author (SG).

One review author transferred extracted data into Review Manager (CP), and a second review author (GC) spot-checked data for accuracy. One review author transferred extracted data on outcomes and subgroup categorisations to SPSS version 24, for importing to STATA version 15.1, for meta-regression analysis. A second review author checked every variable (SG).

Assessment of risk of bias in included studies

In the previous version of this review, we assessed the risk of bias in eligible trials using the risk of bias tool recommended by Cochrane[73]; a single review author (FT) assessed risk, and a second review author verified this (PD). A review author for this update independently rated this information (CP) and discussed discrepancies with a fourth review author (SG).

Two review authors (CP, GC) independently assessed risk of bias, again using the Cochrane risk of bias tool[73]; for studies newly included in this update, review authors discussed discrepancies between them. A third review author (PD) checked risk of bias ratings.

Because of the nature of the interventions studied, it would not be possible to blind personnel or participants to treatment assignment. Therefore, for all included trials, risk of bias should be considered high in that domain. In our risk of bias table, we reported on blinding of outcome assessors only.

Measures of treatment effect

We expressed dichotomous outcomes for each comparison as risk ratios (RRs)with 95% confidence intervals (CIs). We expressed the continuous outcome of adherence as standardised

mean difference, as we noted differences in how the outcome was reported (i.e. percentage or number of sessions).

Unit of analysis issues

We identified one cluster randomized trial[60]. We contacted the trial investigators, who could not provide the information needed to adjust for clustering. Researchers did use generalized estimating equations to account for clustering, and this made little difference in the results. This study has contributed to our numerical analysis as if it were individually randomized. Thus, as we included it in the meta-analysis, we also carried out a sensitivity analysis to determine the effect when we removed this study from the analysis.

Dealing with missing data

We contacted the authors of included studies when an outcome was reported but was not quantified in a manner consistent with the operationalizations herein, such that the study might be precluded from inclusion in meta-analysis or meta-regression.

Assessment of heterogeneity

We first explored heterogeneity amongst included studies qualitatively by comparing characteristics of included studies. We also assessed heterogeneity by visually inspecting forest plots to observe the direction and magnitude of effects and the degree of overlap between CIs for all outcomes, while considering the Chi^2 test (with a P value of 0.10 indicating statistically significant heterogeneity). We also considered the I^2 statistic when we found a considerable number of studies (i.e. ≥ 10) with values around 30% to 60% considered a moderate level of

heterogeneity, and above this indicating substantial heterogeneity[73], warranting further investigation through random-effects meta-regression.

Assessment of reporting biases

We assessed for the presence of publication bias by looking for funnel plot asymmetry and by testing for asymmetry using Egger's test in STATA version 15.1[114,115].

Data synthesis

To perform meta-analysis, we used RevMan 5.3 to combine results when possible[115].We estimated differences between the intervention and usual care by using random-effects models and the DerSimonian-Laird method, as we assumed that estimated effects were not identical between studies.

We conducted univariate meta-regression in STATA version 15.1 to explore heterogeneity and to examine potential intervention effect modifiers, as prespecified below[43]. We performed meta-regression only when we included at least 10 trials for a specific outcome[116]. Given the small number of studies, it was not considered possible to examine more than one subgroup simultaneously. Given the number of tests performed and hence the potential for error, we applied a more conservative P value < 0.01 (with values < 0.05 but > 0.01 considered to signify that future research is needed to explore whether a true effect exists).

Subgroup analysis and investigation of heterogeneity

We conducted the following subgroup analyses when possible (i.e. sufficient number of trials in each category), to explore substantial heterogeneity.

- Intervention intensity (number of contacts; e.g. mail, visit, call).
- Intervention deliverer (nurse or allied healthcare provider vs other or none).
- Delivery format (any face-to-face vs no face-to-face).
- Theory-based intervention (yes vs no).
- Peer navigation (yes vs no).
- Intervention target (patient vs other).
- Outcome ascertainment (self-report vs chart report).
- Multi-centre study (multi-site vs single-centre).
- Cardiac indication (HF included vs HF not included).
- Region (North America vs other).
- Setting of CR (supervised only vs at least some unsupervised provided).
- CR programme duration (three months or longer vs less than three months).
- Intervention timing (delivered before CR vs during CR).

Please note that we considered the last two to be relevant only to the outcomes of adherence and completion.

Sensitivity analysis

We performed a sensitivity analysis to explore the influence of risk of bias, restricting the analysis to studies considered to be at low risk of bias in four of the six Cochrane risk of bias domains.(as per Anderson 2016[3]). We also performed a sensitivity analysis to see the effect when we removed the cluster RCT from the analysis of outcome enrolment.

Summary of findings

We created Summary of findings for the main comparison (Table 1) using the following outcomes: enrolment, adherence, and completion. We used the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to assess the quality of the body of evidence as it related to studies that contributed data to analyses for prespecified outcomes. We applied methods and recommendations described in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions*[73], using GRADEpro software[117] (https://gradepro.org/).

One review author (CP) made judgements about evidence quality while working independently. A second review author (PD) checked these assessments. We justified, documented, and incorporated these judgements into reporting of results for each outcome.

We extracted study data, formatted our comparisons in data tables, and prepared Summary of findings for the main comparison (Table 1) before writing the results and conclusions of this review.

RESULTS

Description of studies

Results of the search

The previous version of this Cochrane review included 18 RCTs[8], of which we considered 11 eligible for the current review upon application of the updated inclusion/exclusion criteria[58,60–63,65,118–122].We have presented reasons for exclusion of the other seven trials in the

Characteristics of excluded studies (Table 3). Reasons were primarily that CR programmes were not comprehensive (i.e. provided exercise only) and that the study was examining degree of exercise rather than utilization of the full CR programme as the outcome. We checked previously excluded studies for eligibility and included one in the current review[49].

The updated electronic search performed in July 2018 yielded 6430 titles after removal of duplicates, and we included seven additional titles derived from handsearching. After reviewing titles and abstracts, we retrieved 119 full-text articles for possible inclusion and excluded 85 studies. Fourteen trials met the inclusion criteria[70–72,123–133].We have illustrated the study selection process in the flow diagram in Figure 2. Thus, we have included 26 trials (5299 participants) in this update and have listed details of these studies in the Characteristics of included studies (Table 2).

Included studies

The previous version of this review included eight RCTs that included 1310 participants and evaluated interventions to increase enrolment (formerly termed "uptake") of CR[58,60–63,65,118,121]; all but one met inclusion criteria for this updated review, as the intervention was delivered post CR[59]. The updated search revealed eight new trials with 1854 participants[49,70,71,123–127]. Thus, we considered 16 trials with 3164 participants that evaluated interventions to increase enrolment in CR. In the previous version of this review, we included eight RCTs with 1374 participants that evaluated interventions to increase adherence to CR[62,68,120,134–138].

Only three trials with 443 participants met the inclusion criteria for this updated review[62,119,120]. Reasons for exclusion of Daltroy 1985[135], Duncan 2003[136], and Sniehotta 2006[68]

were that studies did not offer comprehensive CR (i.e. provided exercise only), and Izawa 2005[137], Arrigo 2008[134], and Moore 2006[138] intervened after CR completion. The updated search yielded eight new trials with 1880 participants[70,72,128–133]. Thus, we considered 11 trials with 2323 participants that evaluated interventions to increase adherence to CR.

Finally, we were the first to examine the outcome of completion in this review. We included three RCTs with 311 participants that were identified in previous reviews and measured this outcome[62,119,122]. The updated search revealed four new trials with 1256 participants[70,126,129,132]. Overall, we included seven RCTs with 1567 participants for this outcome.

Sixteen trials were conducted in North America[49,58,61,62,65,70,71,118–120,122,125,127–129,133], three in Europe[60,63,121], and seven on other continents[72,123,124,126,130–132]. CR programmes on average were 12.8 ± 4.6 weeks in duration (n = 10; 38.4% ≥ 3 months). Three (1.1%) trials offered a women-only (1) or gender-tailored (2) programme (380 participants[61,70,120]). Finally, in eight (30.8%) trials, researchers delivered some or all of the CR programme in an unsupervised setting.

Study design

Twenty-five (96.1%) trials were parallel-group RCTs[49,58,61–63,65,70–72,118–133]. Most trials had two arms, but one had three arms [70], and one used a two by-two factorial design with four arms[123]. One trial was cluster randomized by general practice[60] (see "unit of analysis" subsection above). Jolly 1999[60] evaluated a multi-faceted intervention involving liaison nurses who co-ordinated the transfer of care between hospital and general practice, together with patient-held record cards to prompt and guide follow-up.

Fourteen (53.8%) were multi-centre trials[49,60,65,70–72,119,121,123,124,127,129,130,132]. Most trials had small sample sizes, but three studies included more than 500 participants[60,125,132]. Twenty (76.9%) trials reported funding sources, none or which were industry related [49,58,60–62,65,70–72,118,120–122,124,126,127,129–132].

With regard to funding sources, one (3.8%) trial was not funded[123], and five (19.2%) trials did not report funding sources[63,119,125,128,133]. Eleven (42.3%) trials received government funding[49,58,60,65,72,120–122,126,129,132], eight (30.7%) trials received foundation funding [58,61,70,118,124,130–132], three (11.5%) trials received hospital funding[61,62,118], and two (7.6%) trials received university funding[71,127]. Some trials reported multiple sources of funding.

Participants

Most (i.e. ≥ 50%) participants in 21 (80.7%) trials were male, with rates ranging between 66.0% and 87.2%[58,60,62,63,71,72,118,119,121–133]. Three trials exclusively included women[61,70,120]. Mean age of participants was 63.4 ± 10.4 years. Three trials exclusively focussed on older people (i.e. ≥ 50 years) with a mean age of 76.8 ± 6.6 years[49,65,129]. Most trials included more than one indication for CR (n = 22; 84.6%), and 10 (38.4%) studies included patients with HF in their sample[49,61,62,71,126,127,129,130,132,133]. Please note that 27.2% of participants in one trial received primary prevention[128]. We contacted study authors, but they did not provide data for eligible patients only. We nevertheless included the full sample in this review.

Interventions

Included trials tested a variety of strategies to increase utilization of CR. However, the intervention in many trials consisted of contacts by a healthcare provider during or shortly after an acute care hospitalization.

For example, a few trials utilized a structured telephone call or visit after hospital discharge[58,60,61,121]. Cossette 2012[58] studied the effect of a nursing intervention focussed on illness perceptions that provided a combination of telephone and face-to-face meetings during the 10 days after hospital discharge. Price 2012[61] studied the effects of a nurse-delivered telephone coaching programme. McPaul 2007[121] studied the effects of home visits versus telephone follow-up by an occupational therapist on CR attendance. In eight (30.7%) trials, a nurse or an allied healthcare provider delivered the intervention[49,58,60,61,65,120,121,132]. The intervention to increase utilization involved some face-to-face interaction in 14 (53.8%) studies.

In 15 (57.7%) trials, the interventions were theory-based[49,58,61,63,65,119,120,122–124,128,129,131–133]. For example, Wyer 2001[63] evaluated the effects of motivational letters based on the theory of planned behaviour[139], and others performed evaluations based on social cognitive theory[61,124,129]. Four trials used peer navigation to promote utilization[49,71,118,127].

Eight (30.8%) RCTs offered CR in an unsupervised or hybrid setting as the strategy to increase utilization[70,71,124,126,128–131]; in four studies, these home-based programmes exploited information and communications technology [124,126,130,131].

Overall, interventions to increase utilization consisted of a mean of 14.5 ± 32.3 contacts. Almost all trials (n = 23; 88.5%) targeted the intervention to the cardiac patient; other targets

included nurses[60], family[65], and groups of participants[129]. Thirteen (50.0%) trials delivered the intervention before CR[49,58,60–63,65,71,118,121,123,125,127].

Outcomes

In all 16 RCTs included for enrolment, the outcome could be quantified in a manner comparable with the definition used herein. Of the 11 RCTs included for adherence, we could quantify and report the outcomes for eight (72.7%) studies (contacted study authors when this was not the case) in a manner comparable with the definition used herein (exceptions were [62,72,133]). In all seven RCTs included for completion, again we could quantify the outcome in a manner comparable with the definition used herein. Ultimately, we identified 24 (96.0%) trials that were appropriate for quantitative pooling.

We ascertained outcomes from charts rather than from self-reports for most (n = 13; 50.0%) trials[58,62,63,65,70–72,119–121,127,128,132], and from self-reports for four (15.4%) studies[49,60,61,131]; however, the source of outcome data was unclear for nine (34.6%) trials[118,122–126,129,130,133].

No studies measured arms systematically as a prespecified outcome for the intervention. Trials may have measured adverse events (or lack there of) associated with CR participation. No trials included in the previous version of this review provided information on costs of the intervention nor on other resource implications[8]. Two RCTs included herein incorporated an economic analysis[72,131]. The former trial examined the role of home-based CR in increasing adherence, and the latter assessed the cost utility of offering CR shared between primary care and community rather than in hospital.

Six (23.1%) trials applied strategies to increase utilization of CR in previously under-represented patient subsets of women[61,70,120] and older people[49,65,129] as per our equity focus. For

example, Beckie 2010[120] compared the effects of a gender-tailored CR programme with motivational interviewing versus traditional CR on attendance in exercise and educational sessions, and Grace 2016 [70] compared utilization rates among women referred to supervised mixed-sex (traditional), women-only (not necessarily gender-tailored), or home-based CR. Dolansky 2011[65] studied the effects of a family-directed intervention delivered post acute care to older patients discharged to an inpatient longer-term care facility or receiving home care. Allied healthcare providers in these settings provided cardiac self-management instruction and exercise monitoring.

Excluded studies

As outlined above, we considered excluded studies from the previous reviews for inclusion in this update, given the changes in PICOs, but none met the inclusion criteria. For the current update, we excluded 85 studies after full-text review (Figure 2). We have provided a list of excluded studies, together with reasons for exclusion, in the Characteristics of excluded studies (Table 3). For most (n = 47; 55.3%) studies, the reason for exclusion was that the intervention was not focused on increasing utilization of CR; in 14 (16.5%) studies, CR programmes were not comprehensive (i.e. provided exercise only); in 14 (16.5%) studies, adherence or completion outcomes did not have a comparable CR programme in the control group; seven (8.2%) studies were not randomized; and three (3.5%) studies did not measure the outcomes of interest.

Ongoing studies

The previous review identified two RCT protocols[8]. We considered both studies during full-text screening for this review. We included one RCT[124] and excluded the other[140] as the control group did not receive comprehensive CR.

We identified three new ongoing trials[141–143] One RCT is examining the effects of an "app" on CR enrolment during six to eight weeks post hospital discharge for bypass surgery [141]. Another study is using financial incentives to promote increases in CR utilization among patients of low socioeconomic status[142]. The third study is testing the effects of healing touch therapy while patients wait to enter a CR programme[143]. We have provided details on all these studies in the Characteristics of ongoing studies (Table 5).

Studies awaiting classification

We identified no studies awaiting classification in the previous review. The updated search yielded six completed trials that met the inclusion criteria, for which more information is needed before we can include them in the review[144–149]; we have shown these in the Characteristics of studies awaiting classification (Table 4).

Risk of bias in included studies

We have presented in Figure 3 and Figure 4 the risk of bias for the 26 included trials based on available information. For 18 (69.2%) studies, risk was low in four or more of the six domains.

Allocation

Study authors described all studies as randomized, but five (19.2%) did not report the method of randomization[49,60,121,125,133]. Twenty (76.9%) studies reported details supporting appropriate generation of random sequence[58,61–63,65,70–72,118,120,122–124,126–132], and this method was not satisfactory in one study[119].

Two (7.6%) studies did not conceal allocation before entry to the study[119,128], and 11 (42.3%) studies provided unclear details[49,60,65,72,118,122,125,127,129,132,133]. Thirteen (50.0%) studies adequately described methods used to conceal allocation[58,61–63,70,71,120,121,123,124,126,130,131].

Blinding

Only 11 (42.3%) studies adequately performed blinding of outcome assessors[58,60,61,70,71,118,120,123,128,130,131]. For ten studies, this could not be determined[49,63,65,119,122,124,125,127,129,133], and for five studies, this method was not satisfactory[62,72,121,126,132]. Again, due to the nature of the interventions, blinding of participants and personnel to treatment allocation was not deemed possible. So this is likely a source of bias in all included trials.

Incomplete outcome data

This domain is somewhat conflated with the review outcomes of adherence and completion. Nevertheless, investigators rarely reported reasons for loss to follow-up and for dropout, and they rarely performed intention-to-treat analyses. Only six (23.0%) studies adequately addressed incomplete data[60,62,70,120,128,131].

Selective reporting

Most studies reported all outcomes described in the Methods section or in their associated protocol. Only one (3.8%) study had high risk of bias for selective reporting of outcomes[65].

Other potential sources of bias

Some other potential sources of bias should be considered. First, some studies applied unsupervised programmes as a means to increase utilization. These programmes do not consist of typical onsite sessions. Therefore, adherence would be operationalized, as, for example, completing exercise diaries[126], or logging in to an online system[126]. Thus for these trials, operationalization of adherence would be different in both arms. Moreover, it could be argued that completing online sessions rather than going on-site in person for a discharge assessment are not highly comparable. Therefore, results provided by studies with unsupervised or hybrid arms should be considered closely[70,71,124,126,128–131]. Second, in the CR4HER trial, a number of participants switched treatment groups [70].

Effects of interventions

See: Summary of findings for the main comparison Interventions to promote patient utilization of cardiac rehabilitation. Table 7 shows results of the meta-regression when we found a sufficient number of trials in each subgroup to run the analysis.

Primary outcomes

Enrolment

Compared with control, the effects of interventions to increase enrolment were meaningful (16 trials; 19 comparisons; risk ratio (RR) 1.27, 95% confidence interval (CI) 1.13 to 1.42; participants = 3096; I^2 = 61%; low-quality evidence; Figure 6). Heterogeneity was moderate.

Table 7 shows the numbers of participants for subgroup analyses through meta-regression. The following factors were related to enrolment: intervention deliverer and delivery format. Figure 10 and Figure 11 display the forest plots. As shown, interventions targeting nurses or allied healthcare providers and delivered with at least some face-to-face element were more effective. For the other subgroup analyses that could be performed (i.e. intervention intensity, theory-based intervention, peer navigation, intervention target, outcome ascertainment, multi-centre study, cardiac indication, region and setting of CR), results show no differences between groups. Sensitivity analysis for risk of bias showed that the effect was consistent in trials at low risk (Figure 18). Sensitivity analysis that removed the cluster randomized controlled trial[60] did not alter the main finding (Figure 19).

Adherence

Eight of 11 trials reported sufficient information for extraction or computation of standard deviations and operationalized adherence as per the definition herein; these trials reported the same numbers of prescribed sessions across all comparisons and hence could be pooled for meta-analysis. The number of trials was insufficient for performance of meta-regression.

Regarding the trials that could not be quantitatively pooled, Pack 2013[62] showed no differences in adherence rates with early initiation of CR (within 10 days of hospital discharge)

than with usual access timing (i.e. 35 days). Bertelsen 2017[72] showed no improvement in adherence with a community-based model in which multiple healthcare workers provided care (including primary care) versus usual hospital-based CR. Finally, McGrady 2014[133] showed that four-session motivational interviewing and stress management/relaxation in addition to standard CR intervention resulted in significantly less dropout when compared with standard CR alone. Results of meta-analysis revealed low-quality evidence suggesting that interventions to increase adherence had a positive effect (eight trials; nine comparisons; standardised mean difference (SMD) 0.38, 95%CI 0.20 to 0.55; participants = 1654; I^2 = 53%; Figure 20). Heterogeneity was moderate. Subgroup analyses suggest that interventions were more effective when CR was delivered in an unsupervised setting (SMD 0.56, 95% CI 0.37 to 0.76; participants = 451; studies = 5; I^2 = 6%; test for subgroup differences $P < 0.00001$; Figure 25). These findings should not be over-interpreted however, given, for instance that only five small studies looked at settings. The other subgroup analyses that could be performed (i.e. intervention deliverer, delivery format, theory-based intervention, multi-centre study, cardiac indication and region) revealed no differences between groups.

Sensitivity analysis for risk of bias showed that the effect was consistent in trials at low risk (Figure 28).

Completion

Compared with controls, the effects of interventions to increase CR completion were promising (7 trials; 8 comparisons; RR 1.13, 95% CI 1.02 to 1.25; participants = 1565; I^2 = 47%; moderate quality evidence; Figure 29). The number of trials was insufficient for meta-regression

to be undertaken. Sensitivity analysis for risk of bias showed that the effect was consistent in trials at low risk (Figure 37).

Heterogeneity was moderate. Note that in the forest plot, the effect size for Varnfield 2014[126] is considerably larger than for the other studies, and this could be the source of some heterogeneity. Close consideration of the effect of this trial is warranted.

Subgroup analysis through meta-analysis (Table 7) revealed that the following factor was related to greater completion: number of sites (RR 1.46, 95% CI 1.17 to 1.82; participants = 388; studies = 3; I^2 = 8%; Figure 33). Single-site studies more often resulted in greater completion than multi-site ones, suggesting that there may be an issue for generalizability of the interventions tested. The other subgroup analyses that could be performed (i.e. intervention intensity, intervention deliverer, delivery format, theory-based intervention, intervention target, cardiac indication, region and setting of CR, intervention timing, CR programme duration) showed no differences between groups.

Secondary outcomes

Information on the harms of utilization interventions was not reported. In both trials reporting on costs, the approach used to increase utilization was to deliver CR outside of a hospital setting. In one of the two studies that examined cost[131], researchers suggested that home-based CR may be more cost-effective than traditional supervised CR from a societal perspective. In the other study[72], study authors stated that average costs to deliver CR in the hospital versus shared between primary care and community were comparable, as were productivity losses in participants, in either model. They suggested that the shared care model could be cost-effective.

In terms of equity, investigators tested interventions designed to improve utilization among women[61,70,120], as well as among older patients[49,65,129], but review authors could not pool these data quantitatively. With regard to the former, results suggest that offering alternative models including women-only programmes alone may not be effective in increasing utilization[70], but tailoring existing models to meet women's unique needs by providing a motivational orientation may be effective[120]. For older participants, peer navigation or post discharge visits may improve enrolment, and group sessions promoting self-regulation skills may increase completion. No studies compared intervention effects by subpopulation.

Publication bias

We could not generate funnel plots for adherence and completion, as we identified too few studies. The funnel plot for enrolment is shown in Figure 5. The funnel plot showed a degree of asymmetry, but this was not supported by statistical analysis (Egger's test; P = 0.24).

Quality of evidence from randomized controlled trials

Based on the GRADE method[117], we determined that the quality of evidence was low for enrolment and adherence, and was moderate for completion (Table 1. Summary of findings for the main comparison). We downgraded the evidence for the outcomes of enrolment and adherence due to heterogeneity across studies and indirectness (mostly male samples). We downgraded the evidence for completion due to indirectness (mostly male samples).

DISCUSSION

CR supports recovery from coronary events and reduces the risk of future morbidity and mortality. Despite this, utilization of CR is below recommended levels, especially in certain subgroups, including women. The aim of this systematic review was to determine the effects of interventions to increase patient enrolment in, adherence to, or completion of CR.

Summary of main results

Primary outcomes

Enrolment in cardiac rehabilitation

In this first quantitative pooling of trials of interventions to increase CR enrolment, it is established that such approaches are indeed successful, resulting in 27% greater enrolment than is observed with usual care. Heterogeneity is substantial, suggesting that some strategies are more effective than others. Interventions may be more successful if delivered by nurses or other allied healthcare professionals (e.g. physiotherapists), face-to-face, although further research is required to explore true effects, given the reported P values.

Adherence to cardiac rehabilitation

Researchers also found strategies to increase CR adherence to be effective. Unsupervised delivery appears to be key to increasing programme adherence.

Completion of cardiac rehabilitation

Again, in this first quantitative pooling of trials of interventions to increase CR completion, it is established that such approaches are indeed successful, resulting in 13% greater completion than is observed with usual care. However, caution is warranted, as heterogeneity is moderate, and effects are greater in single-centre versus multi-centre studies. None of the other characteristics that could be examined were meaningful.

Secondary outcomes

Harms or adverse effects of interventions to increase CR utilization are not considered in the literature. No trial considered the cost of delivering a utilization intervention specifically. Given the nature of some of the interventions (e.g. healthcare providersmaking postdischarge home visits), these costs could be considerable and should be quantified in future trials. These costs would substantially impact implementation in the real world. Some tested interventions however could be particularly low cost (e.g. motivational letter by Wyer 2001[63]), and hence could be scaled up across the cardiac population.

It is encouraging that researchers specifically tested some interventions to increase CR utilization in under-represented groups. Qualitative analysis suggests that gender-tailored programmes with a motivational orientation may promote utilization among women. For older patients, researchers identified a few promising interventions.

Overall completeness and applicability of evidence

Despite the fact that some included studies considered women and older patients specifically, most study participants included in this review were middle-aged male patients with

acute coronary syndrome (± revascularization). More studies in this review included patients with heart failure (HF) (only 13 participants in Duncan 2003[136] from the previous Karmali 2014[8]), which is encouraging, given that this is now a recognised indication for CR[88], yet such patients may avoid exercise due to fear of placing excessive strain on the heart or because of functional limitations. The identification of effective techniques to increase CR utilization in people with HF may, therefore, be particularly valuable.

Ethnicity often was not reported within the included studies (nine studies; 36.0%). Comorbidity burden or risk factors, such as diabetes (11 studies; 44%), smoking status (six studies; 24%), and depression (five studies; 20%), were seldom reported. This is a major gap given the impact of these factors on CR utilization.

The identified studies have evaluated a range of different techniques to increase utilization. As evidenced by the degree of heterogeneity, interventions were usually multi-faceted, and researchers studied many different combinations of techniques. Very few studies evaluated a single intervention strategy. Moreover, all aspects of the interventions were not consistently reported in accordance with reporting guidelines[150], nor was content provided open source, such that the interventions could be readily replicated and tested. Although this review provides preliminary evidence that interventions to increase CR enrolment should be delivered face-to-face by a nurse or an allied healthcare provider, and that adherence interventions should alternatively be delivered remotely, we can provide little guidance on what the content of the structured contacts should entail.

In a literature review, Beswick identified a broad range of suggested interventions for increasing utilization of CR[105], most of which have not been formally evaluated. Non-randomized studies have tested other interventions, which warrant testing in randomized

controlled trials (RCTs), including systematic referral for augmenting enrolment[151], among other quality improvement approaches[62].

Few to no interventions identified in reviews have specifically targeted multi-level barriers[104] such as those at the health system, provider, programme, and patient levels. Moreover, interventions have rarely targeted barriers frequently cited by patients[100,103,152]. Several studies did address transport difficulties and inconvenient timing by offering CR in unsupervised settings. Only one study identified illness perceptions of targeted patients[58]. Given the failure to identify specific approaches to increase completion, factors associated with utilization following referral, as reviewed in Taylor 2011[153], warrant consideration.

Quality of the evidence

Although the quality of reporting tended to be poorer for older studies and was improved in studies included from the updated search, this update reveals limitations in available RCT evidence examining interventions to promote utilization of CR. Several studies have not provided enough detail to allow assessment of their potential risk of bias (Figure 3; Figure 4). Study authors have not consistently described details of allocation concealment and blinding of outcomes assessment. Most trials insufficiently addressed incomplete outcome data (primarily due to losses to follow-up or dropouts) and rarely reported or performed intention to treat analyses. It is reassuring to note that sensitivity analyses for two utilization outcomes that could be tested show no substantial moderation of effect when only trials at low risk of bias are included.

The interventions evaluated were varied and were often multifaceted, limiting our ability to determine consistency of findings. The small body of evidence for adherence in particular and

the multi-faceted nature of the interventions evaluated mean that study findings are highly heterogeneous. In addition to indirectness due to homogeneity of included participants, this heterogeneity resulted in the GRADE rating of low to moderate for all outcomes.

Potential biases in the review process

Due to the nature of the interventions, blinding of participants and personnel to treatment allocation was not possible. Instead, we evaluated blinding of outcome assessors. Nevertheless, the lack of blinding of participants and personnel may introduce a potential source of bias in all these studies.

Finally, as outlined above, utilization measurement in supervised and unsupervised settings may not be comparable. Careful consideration of outcome ascertainment in such trials is needed in future research.

Agreements and disagreements with other studies or reviews

An observational study has suggested that offering too much reassurance and optimism to patients about their recovery during CR discussions at the bedside may be associated with reduced enrolment[154]. Although none of the interventions tested in the included studies were associated with significantly lower utilization, it remains clear that the content of structured communications during interventions should be considered and standardised.

The safety and comparable efficacy of CR offered in non-supervised settings have been well established[155–157], and thus there should be no concern about harm in this regard. One trial did look at cost, and results suggest potentially lower costs with home-based versus traditional CR[131]. However, the Cochrane Review on this topic suggests equivalent costs of home versus

supervised CR, concluding that an economic benefit is not likely associated with CR offered in alternative settings.

CONCLUSIONS

Implications for practice

This review reveals that interventions can increase utilization of CR. The quality of evidence is low to moderate due to heterogeneity of the interventions used among other factors. Effects on enrolment were larger in studies where the intervention was delivered face-to-face by a nurse or an allied healthcare provider, whereas the effect on adherence was larger in studies where the intervention was delivered remotely. These results should not be over-interpreted, as trials supporting these subgroup analyses were few and had relatively small sample sizes. The resource implications of face-to-face contacts with patients, particularly post-acute care discharge, warrant serious consideration, as they may not be feasible.

Implications for research

Interventions to promote greater CR utilization among patients of lower socioeconomic status, as well as in ethnocultural minority groups, are greatly needed. Studies have not reported intervention effects by these characteristics. Given recommendations for sex and gender-based analyses as well, all future trials should report results of these[158]. Further trials of gender-tailored CR with mixed-sex comparison arms are needed to provide sufficient power to test whether or not this approach increases utilization. Other strategies intended to increase use among women have been recently reviewed and should perhaps be the subject of an RCT[159]. Intervention effectiveness in patients with HF and in those with comorbidities also remains to be tested. At

this time, no well-established interventions are known to increase CR utilization in under-represented groups.

As there is a good rationale for increasing utilization of CR, further high-quality research is needed to examine how the interventions work and to ensure that they are replicable. Pooling of these diverse interventions is not informative for practice if there is no commonality and no understood mechanism. Interventions should be standardised/manualised for ready testing in real-world practice with barriers to utilization in mind. Evaluation of single strategies will make it easier to identify the "active ingredients" of interventions. Moreover, the beneficial and adverse effects of these interventions should be studied within the context of the costs and resources that they require.

Figure 2**.** Flow diagram of the study selection process for this update (Study 1)

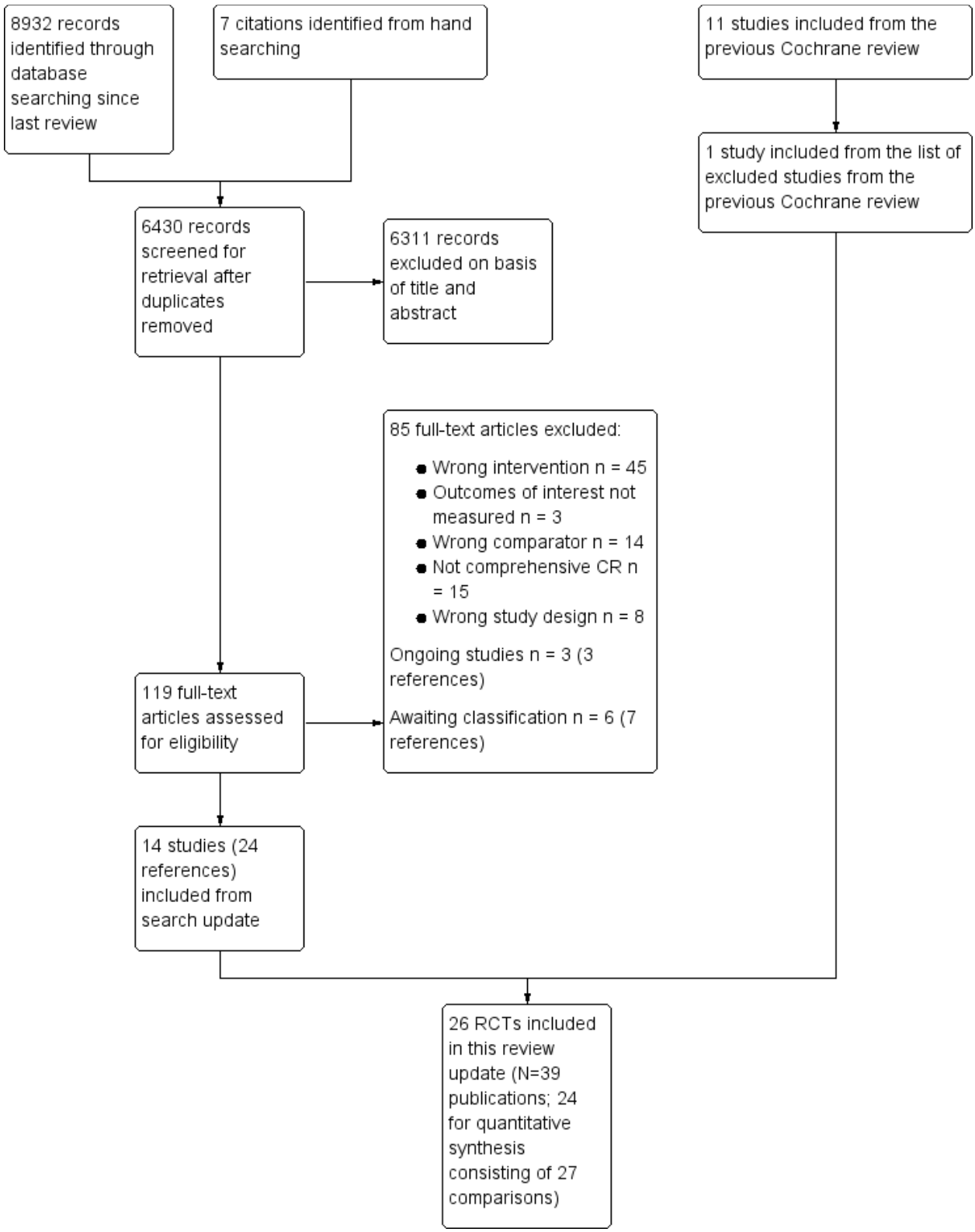


Figure 3**.** Methodological quality graph: review authors' judgments about each risk of bias element presented as percentages across all included studies

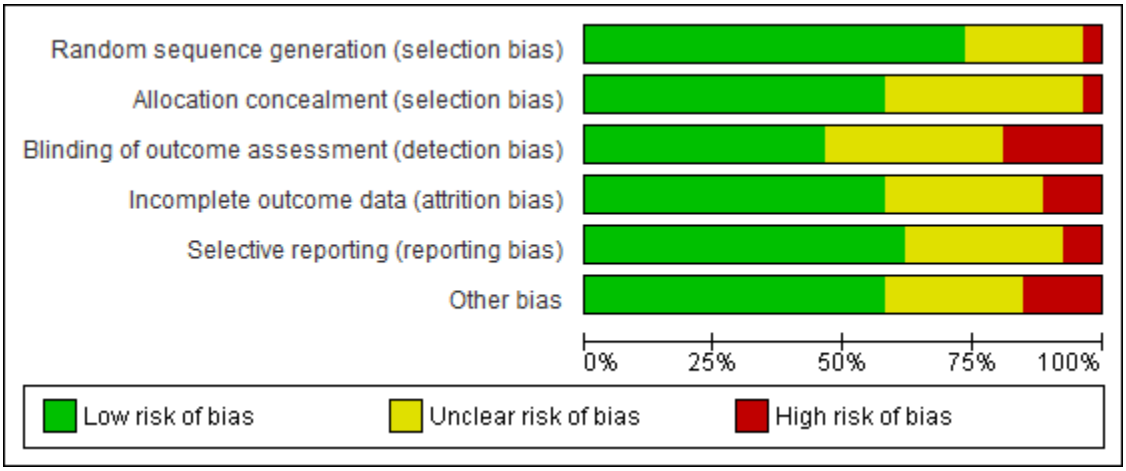


Figure 4**.** Methodological quality summary: review authors' judgments about each risk of bias item for each included study

Figure 5**.** Funnel plot of comparison: 1 CR utilization, outcome: 1.1 Enrolment

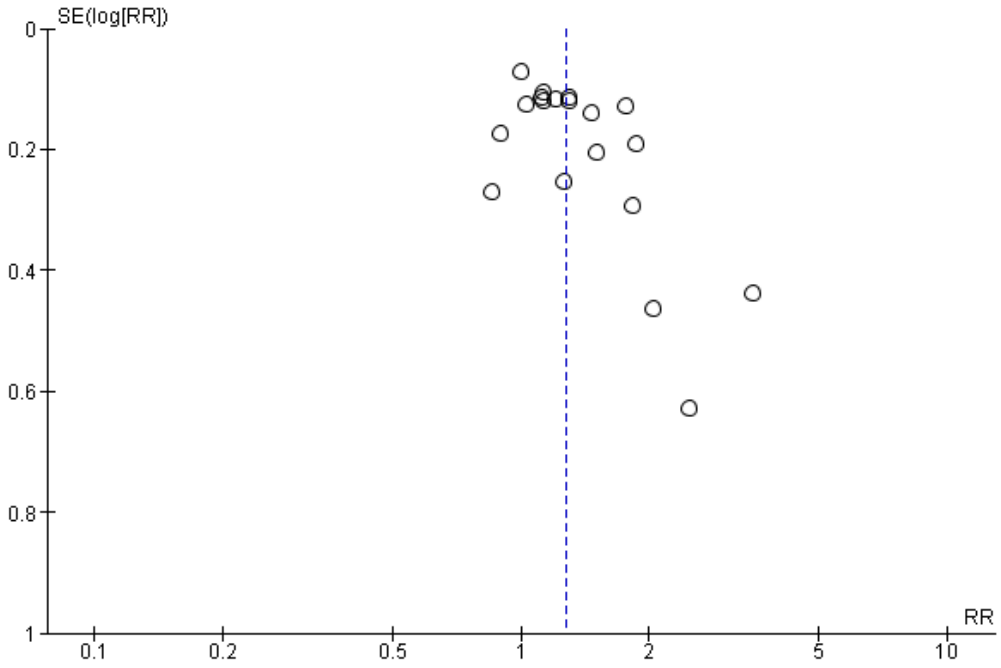


Table 1**.** Summary of findings for the main comparison (Study 1)

Patient or population: adults (age 18 years or over) with myocardial infarction, stable angina, following coronary artery bypass graft surgery or percutaneous coronary intervention, or with heart failure who were eligible for cardiac rehabilitation (CR)
Setting: cardiac or primary care
Intervention: any interventions with the specific aim of increasing patient enrolment, adherence, or completion of comprehensive CR
Comparison: comparison arm - participants had to have an equivalent opportunity to attend a CR programme

Outcomes	**№ of participants (studies) Follow up**	**Certainty of the evidence (GRADE)**	**Relative effect (95% CI)**	**Anticipated absolute effects* (95% CI)**	
				Risk with no interventions to promote utilization of CR	**Risk difference with interventions to promote utilization of CR**
Enrolment	3096 (19 RCTs)	⨁⨁⊖⊖ LOW [1 2]	RR 1.27 (1.13 to 1.42)	Study population 406 per 1,000	110 more per 1,000 (53 more to 171 more)
Adherence	1654 (9 RCTs)	⨁⨁⊖⊖ LOW [1 2]	-		SMD 0.38 SD higher (0.20 higher to 0.55 higher)
Completion	1565 (8 RCTs)	⨁⨁⨁⊖ MODERATE [2]	RR 1.13 (1.02 to 1.25)	Study population 649 per 1,000	84 more per 1,000 (13 more to 162 more)
Adverse events	This outcome was not reported by any of the included studies				

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). CI: Confidence interval; RCT: Randomized controlled trial; RR: Risk ratio; SD: Standard deviation SMD: Standardized mean difference

Table 2. Characteristics of included studies *[ordered by study ID]*

Ali Faisal 2016

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Date patients recruited:** May 2014 to December 2014
Participants	**Inclusion criteria:** adult cardiac inpatients eligible for CR with ACS, PCI, CABG, valve surgery, arrhythmia, stable HF, congenital heart disease, and/or non-disabling stroke **Exclusion criteria:** major musculoskeletal, neuromuscular, visual, cognitive, or non-dysphoric psychiatric condition, or any serious or terminal illness; discharged to long-term care; unable to ambulate; not residing in Ontario, Canada **N randomized:** total: 94; intervention: 46; comparator: 48 **N lost to follow-up:** total: 18; intervention: 7; comparator: 11 **N analysed:** total: 76; intervention: 39; comparator: 37 **Age (mean ± SD):** intervention: 62.6 ± 13.1; comparator: 62.7 ± 16.5 **Sex (% women):** intervention: 30.4%; comparator: 31.2% **Race/ethnicity (% white):** intervention: 82.6%; comparator: 83.0%
Interventions	**Intervention:** peer navigation intervention. Participants were visited at the bedside by the CR peer navigator to build rapport and encourage the participant to obtain a CR referral from his or her healthcare provider before discharge from the hospital. A "get well soon" card was mailed by the CR navigator to the participant's home. Two weeks after discharge, the CR navigator called the participant to discuss any barriers to CR enrolment **Comparison:** received eReferral system as part of usual care

	Theoretical basis: NR **Intervention provider:** peer **Mode of delivery:** face-to-face + card + telephone call **Time of delivery:** pre-CR **Intervention intensity:** 3 contacts **Intervention target:** patient **Materials provided:** written materials about the benefits of CR **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined as patient attendance at first CR programme visit
Notes	**Sponsorship source:** funding from Stony Brook University (United States), Toronto General and Western Hospital Foundation, Peter Munk Cardiac Centre campaign (Canada)

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomization sequence was generated by a statistician and was stratified by sex in random blocks of 4, 8, and 12
Allocation concealment (selection bias)	Low risk	Random assignment was concealed through the use of opaque envelopes
Blinding of outcome assessment (detection bias)	Low risk	CR enrolment and referral were ascertained by a research assistant blinded to random assignment
Incomplete outcome data (attrition bias)	Unclear risk	15% and 23% of participants in the intervention and control groups, respectively, were lost to follow-up
Selective reporting (reporting bias)	Low risk	The protocol is not available; however study authors verified that all of the study's prespecified (primary and secondary) outcomes of interest to the review have been

		reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

Ashe 1993

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** October 1992 to December 1992
Participants	**Inclusion criteria:** patients referred to CR programmes following a variety of heart problems: angina, MI, valve problems, CABG, and coronary artery disease **Exclusion criteria:** NR **N randomized:** total: 41. intervention: 21; comparator: 20 **N lost to follow-up:** none **N analysed:** total: 41; intervention: 21; comparator: 20 **Age (mean ± SD):** intervention: 62.6 ± 13.1; comparator: 62.7 ± 16.5 **Sex (% women):** intervention: 30.4%; comparator: 31.2% **Race/ethnicity (% white):** 95% intervention: 82.6%; comparator: 83.0%
Interventions	**Intervention:** the trial offered a motivational relapse prevention intervention that was delivered during the course of the CR programme. The intervention was started after 4 or 5 exercise sessions. The intervention was based on Marlatt and Gordon's model. Participants received individual sessions, once a week for 3 weeks *Session 1*: based on pretest information, factors found to interfere with adherence were introduced. Participants discussed their perceptions on the value of exercise, listed their goals for the programme, and anticipated outcomes

	Session 2: participants were introduced to decision-making concepts and cognitive interference factors. Discussion with regard to coping with "slips" and introduction to appropriate ways to re-frame perspectives. Participants filled in daily activity sheets *Session 3*: focussed on the importance of lifestyle balance. Participants were asked to refer to daily activity sheets to introduce concepts of shoulds and wants. Stressors were identified that may affect lifestyle balance and were discussed, as was the importance of positive thinking and use of medication **Comparison:** during the course of the exercise programme, participants received a "benign" education intervention, which covered basic exercise concepts, guidelines for proper exercise participation, exercise tips and handouts, and the benefits of exercise **Theoretical basis:** Marlatt and Gordon's relapse prevention model **Intervention provider:** experimenter **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 3 contacts **Intervention target:** patient **Materials provided:** handouts **Tailoring:** NR **CR setting:** supervised
Outcomes	Adherence - defined as total number of prescribed sessions completed Completion - defined as completion of the programme after a follow-up assessment
Notes	**Sponsorship source:** NR

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Allocated to groups by presenting patients with a packet containing a form coded A or B
Allocation concealment (selection bias)	High risk	Allocation was unlikely to have been concealed due to the use of alternate allocation in assigning participants to treatment groups
Blinding of outcome assessment (detection bias)	Unclear risk	Not reported
Incomplete outcome data (attrition bias)	Low risk	9 (22%) dropouts matched between treatment allocation, but reason not provided
Selective reporting (reporting bias)	Unclear risk	Insufficient information to permit judgement of "low risk" or "high risk". Study protocol not available to identify unreported outcomes
Other bias	Unclear risk	Similarity of groups at baseline unclear

Beckie 2010

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** January 2004 to March 2008
Participants	**Inclusion criteria:** women aged > 21 years old referred to an outpatient CR programme with multiple CHD conditions/procedures (MI, angina, or CABG) and able to read, write, and speak English **Exclusion criteria:** lack of insurance coverage for 36 exercise sessions, cognitive impairment, inability to ambulate, implantation of internal cardiac defibrillator in the last year **N randomized:** total: 252; intervention: 141; comparator: 111 **N lost to follow-up:** total: 11; intervention: 7; comparator: 4 **N analysed:** total: 252; intervention: 141; comparator: 111

	Age (mean ± SD): intervention: 63.0 ± 11.0; comparator: 64.0 ± 11.0 **Sex (% women):** intervention: 100%; comparator: 100% **Race/ethnicity (% white):** overall: 82%
Interventions	**Intervention:** gender-tailored CR programme in which participants exercised exclusively with women. Psychologists and nurse specialists provided to participants 1-hour individualised motivational interviewing sessions at weeks 1 and 6 based on the transtheoretical model (TTM) of behaviour change. Psychoeducational classes were held weekly before exercise sessions **Comparison:** traditional CR programme based on the case management model that was delivered by female nurses and exercise physiologists. The exercise protocol consisted of aerobic and resistance training 3 days/week for 12 weeks. CR personnel provided educational classes focussed on CHD risk factor modification at 5 different times weekly **Theoretical basis:** transtheoretical model of behaviour change + motivational interviewing **Intervention provider:** research nurse + exercise physiologists **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 36 contacts (delivered during each CR session) **Intervention target:** patient **Materials provided:** 280-page educational manual **Tailoring:** participants received 1-hour individualised motivational interviewing (MI) sessions at weeks 1 and 6 with a clinical psychologist or a clinical nurse specialist formally trained in motivational interviewing focussed on factors affecting women's CR utilization **CR setting:** supervised
Outcomes	Adherence - defined as exercise session attendance and educational session attendance
Notes	**Sponsorship source:** National Institutes of Health grant 5 RO1 NR007678, Florida, USA

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Biased coin randomization was performed
Allocation concealment (selection bias)	Low risk	Statistician provided treatment assignment sheets that were placed in opaque envelopes, sealed, and delivered to the project director
Blinding of outcome assessment (detection bias)	Low risk	Completely separate and blinded outcome assessors (a dedicated research nurse with no contact with participants during the intervention) collected all 3-month and 6-month follow-up data
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	Low risk	Confirmed with study author that all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	Groups were comparable at baseline, including all major prognostic factors

Benz Scott 2013

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** May 2009 to June 2011
Participants	**Inclusion criteria:** ≥ 21 years old with MI, stable HF, PCI, CABG, or valve surgery **Exclusion criteria:** psychiatric disorders, substance abuse, non-English-speaking, assisted living, did not have a phone **N randomized:** total: 181; intervention: 90; comparator: 91 **N lost to follow-up:** total: 3; intervention: 1; comparator: 2 **N analysed:** total: 178; intervention: 89; comparator: 89

	Age (mean ± SD): intervention: 60.2 ± 9.9; comparator: 60.7 ± 11.1 **Sex (% women):** intervention: 36.0%; comparator: 31.5% **Race/ethnicity (% white):** intervention: 87.7%; comparator: 85.5%
Interventions	**Intervention:** participant navigators provided basic information and support to participants at hospital bedside, by phone, or by mail. Participants were given information about CR (i.e. likely benefits of participation, locations of local programmes, and details on how to access CR), and their navigator facilitated enrolment into a programme **Comparator:** the control group received standard discharge instructions provided to all participants **Theoretical basis:** NR **Intervention provider:** peer **Mode of delivery:** face-to-face or letter + telephone call **Time of delivery:** pre-CR **Intervention intensity:** 2 contacts **Intervention target:** patient **Materials provided:** letter about the benefits of CR **Tailoring:** NR **CR Setting:** NR
Outcomes	Enrolment - defined as having attended at least 1 outpatient CR session (beyond that for initial intake assessment)
Notes	**Sponsorship source:** funded by Grants for Catalyzing Research Clusters GRANT # MO1RR10710 and a Targeted Research Opportunity Fusion Award, with matching funds provided by the Schools of Medicine and Health Technology & Management

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "All consenting patients were consecutively assigned to either intervention or usual care groups using computer-generated block randomization"
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Blinding of outcome assessment (detection bias)	Low risk	Quote: "The in-depth interviews were conducted by a group of survey researchers located at the Center for Survey Research at Stony Brook University who worked independent of the authors/investigative team, and they were not aware of patient assignment while conducting the interviews"
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were reported
Selective reporting (reporting bias)	Low risk	The study protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	High risk	Despite random assignment to study groups, more participants with HF were included in the usual care group than in the intervention group

Bertelsen 2017

Methods	**Study design:** RCT parallel - 2 arms **Country:** Denmark **Date patients recruited:** October 2011 to March 2013
Participants	**Inclusion criteria:** > 18 to 80 years of age, angiographically documented coronary thrombosis or stenosis, resident in one of the participating municipalities: Aarhus, Viborg, Silkeborg, Skive, Samsø, Favrskov, or Skanderborg; no previous CR **Exclusion criteria:** MI on a non-thrombotic basis, ejection fraction < 40%, lack of physical or mental ability to participate in CR, inability to write and understand Danish without help, other disease causing severe disability **N randomized:** total: 212; intervention: 106; comparator: 106

	N lost to follow-up: total: 22; intervention: 9; comparator: 13 **N analysed:** total: 190; intervention: 97; comparator: 93 **Age, mean (range):** intervention: 60 (40 to 79); comparator: 60 (30 to 78) **Sex (% women):** intervention: 29.2%; comparator: 20.7.5% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** CR delivered through shared care. The general practitioner was responsibility for CR components not delivered in the community, as well as for pharmacological treatment and risk factor management after the initial visit to the hospital outpatient clinic. Municipal healthcare centres provided courses on smoking cessation, nutrition, and exercise training, along with patient education and psychosocial support **Comparison:** CR was delivered entirely within hospital outpatient clinics. CR was terminated upon consultation with a cardiologist concerning risk factors and future medication **Theoretical basis:** NR **Intervention provider:** NA **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 3 contacts **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** hybrid
Outcomes	Adherence - defined as a composite of participation in different components of the programme

	(smoking cessation, dietary advice, exercise training, clinical assessment by a doctor, and patient education)
Notes	**Sponsorship source:** funded by the Central Region Denmark as part of the chronic care programme

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer randomization was performed after consent was obtained
Allocation concealment (selection bias)	Unclear risk	Information was insufficient for judgement; information was not presented in the paper
Blinding of outcome assessment (detection bias)	High risk	Study authors declared that blinding was not possible
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were reported
Selective reporting (reporting bias)	Low risk	The study protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

Carroll 2007

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** January 2004 to March 2008
Participants	**Inclusion criteria**: > 65 years old, diagnosis of MI or CABG, unpartnered (single, widowed, divorced), able to speak and read English, had access to a telephone **Exclusion criteria:** NR **N randomized:** total: 247; intervention: 126; comparator: 121 **N lost to follow-up:** none

	N analysed: total: 247; intervention: 126; comparator: 121 **Age (mean ± SD):** intervention: 76.4 ± 6.4; comparator: 76.2 ± 6.2 **Sex (% women):** intervention: 63.0%; comparator: 69.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** standard of care plus community-based collaborative peer advisor and advanced practice nurse intervention. The intervention was started within 48 hours of discharge and lasted 12 weeks. A nurse made a home visit and contacted participants over the telephone at least 3 times during the intervention; the peer advisor made weekly calls to participants for 12 weeks **Comparison:** standard of care (CR) **Theoretical basis:** social cognitive theory **Intervention provider:** nurse + peer. Peer advisors were recruited from CR programmes, were older than 60 years, had a history of MI or CABG, had successfully completed a CR programme, and were actively participating in a healthy lifestyle **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 16 contacts **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** supervised
Outcomes	Enrolment - defined as enrolment in a CR programme
Notes	**Sponsorship source:** grant from the National Institute of Nursing Research (RO1 NR05205)

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Information about the sequence generation process was insufficient to permit judgement of "low risk" or "high risk"
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	High risk	12 participants died and 34 dropped out of the study (18.6% attrition rate). Dropout reasons were not reported
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol was not available to identify unreported outcomes
Other bias	Low risk	The study appears to be free of other sources of bias

Cossette 2012

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Date patients recruited:** October 2006 to September 2009
Participants	**Inclusion criteria:** adult patients hospitalised for suspected acute coronary syndrome **Exclusion criteria:** discharged to a short-term rehabilitation centre or to long-term care; inability to speak French or English; living more than 50 miles away from the rehabilitation centre; having physical, psychological, or cognitive problems; referred for surgery; already receiving regular outpatient follow-up; previously completed a CR programme; final diagnosis other than acute coronary syndrome **N randomized:** total: 242; intervention: 121; comparator: 121 **N lost to follow-up:** none

	N analysed: 242; intervention: 121; comparator: 121 **Age (mean ± SD):** intervention: 59.4 ± 10.5; comparator: 59.4 ± 9.4 **Sex (% women):** intervention: 19.0%; comparator: 9.9% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** 3 encounters over 10 days. The first encounter was face-to-face and occurred before discharge to address participants' symptoms and physical activity after discharge, understanding of the illness, and concerns and worries. The second encounter occurred 3 days post discharge via telephone call and focussed on participants' clinical condition, including their ability to manage the disease. The third encounter occurred 10 days post discharge via telephone call or hospital meeting with the focus of addressing risk factors and lifestyle modification including CR enrolment **Comparison:** participants were referred to the rehabilitation centre affiliated with the academic hospital and were encouraged to call the rehabilitation centre themselves to schedule an appointment. All study participants received telephone calls from staff to enrol in CR, and those who accepted were scheduled for a first appointment within 6 weeks of discharge **Theoretical basis:** Leventhal's self-regulation theory **Intervention provider:** research nurse + exercise physiologists **Mode of delivery:** face-to-face and telephone call **Time of delivery:** pre-CR **Intervention intensity:** 3 contacts **Intervention target:** patient **Materials provided:** NA **Tailoring:** NR **CR setting:** NR

Outcomes	Enrolment - defined as at least 1 visit to CR
Notes	**Sponsorship source:** Fonds de la Recherche en Sante du Quebec (FRSQ), the Quebec Inter-university Nursing Intervention Research Group (GRIISIQ), and the Montreal Heart Institute Foundation and Research Center. CR was free of charge. Enrolment at surrounding rehabilitation facilities was not ascertained

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomization was carried out in advance by a statistician at the co-ordinating centre
Allocation concealment (selection bias)	Low risk	Study nurses were provided with sealed opaque envelopes that they opened after each participant had completed the baseline questionnaire
Blinding of outcome assessment (detection bias)	Low risk	Enrolment in CR was assessed by database as well as by independent data entry performed by the co-ordinating centre
Incomplete outcome data (attrition bias)	Low risk	Reasons for exclusion and withdrawal were reported
Selective reporting (reporting bias)	High risk	Study was registered as ISRCTN95784143. Study authors listed health services utilization as a secondary outcome in the trial registry, above the primary outcome of enrolment that was reported. However no other health services utilization outcome was reported in the paper
Other bias	High risk	Control group had more men and higher rates of obesity and physical inactivity. The intervention arm included more people with hypertension

Dolansky 2011

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** NR
Participants	**Inclusion criteria:** adults 65 years of age or older admitted to a nursing facility or receiving home healthcare following hospitalization for a cardiac event

	Exclusion criteria: NR **N randomized:** total: 40 (subgroup not specified) **N lost to follow-up:** 2 **N analysed:** total: 38; intervention: 17; comparator: 21 **Age (mean ± SD):** intervention: 77.6 ± 6.9; comparator: 76.5 ± 6.7 **Sex (% women):** intervention: 52.9%; comparator: 71.4% **Race/ethnicity (% white):** intervention: 52.9%; comparator: 61.9%
Interventions	**Intervention:** the Cardiac TRUST programme, which consisted of cardiac self-management instruction and exercise monitoring during the immediate post-acute care period. The educational component consisted of 2 × 30-minute family sessions to identify values/goals, develop problem-solving and decision-making skills, and establish healthcare partnerships. The action component consisted of monitoring the cardiac response to physical therapy. A prescription for distance to walk was provided and was progressively increased each day. Participants were taught to rate their exertion and keep an exercise log. Family members were encouraged to participate in walking sessions **Comparison:** all participants received usual post-acute care services that included daily sessions of physical and occupational therapy, as well as discharge instructions on physical activity, medications, and follow-up **Theoretical basis:** self-management framework **Intervention provider:** nurse **Mode of delivery:** face-to-face **Time of delivery:** pre-CR **Intervention intensity:** 2 contacts

	Intervention target: patient and family **Materials provided:** NA **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined as outpatient CR attendance at 6 weeks post discharge
Notes	**Sponsorship source:** award number P30NR010676 from the National Institute of Nursing Research Each participants was given USD20 for participation in the study. Nine participants with missing data were excluded from analysis

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers table was used
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	High risk	Satisfaction was reported for the intervention arm but not for the control arm
Other bias	Unclear risk	Groups were comparable across major prognostic factors, but more participants in the usual care arm were caregivers, lived with others, and were African American

Farias-Godoy 2013

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Date patients recruited:** May 2006 to May 2010
Participants	**Inclusion criteria:** men and women with risk factors for IHD (primary prevention) or documented IHD

	(secondary prevention) accepted into CR; secondary prevention patients classified as low or moderate risk according to AACVPR risk stratification criteria **Exclusion criteria:** presence of poorly controlled metabolic risk factors; scheduled revascularization procedures; unlikely to survive due to non-cardiac causes; psychiatric diagnosis that would interfere with compliance; congenital heart disease with no IHD risk factors **N randomized:** total: 121; intervention: 61; comparator: 60 **N lost to follow-up:** total: 19; intervention: 11; comparator: 8 **N analysed:** total: 102; intervention: 50; comparator: 52 **Age (mean ± SD):** intervention: 61.6 ± 10.5; comparator: 60.6 ± 10.7 **Sex (% women):** intervention: 18.0%; comparator: 20.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** reduced (i.e. shorter) CR programme. The programme was designed to include the core elements of standard CR, with fewer hospital-based exercise sessions (10 sessions). The first 2 weeks was the same for both groups (a total of 2 in-hospital exercise sessions/week), and during this time, participants were able to learn exercise routines and were evaluated by staff **Comparison:** hospital-based CR over 4 months (32 sessions) **Theoretical basis:** transtheoretical model of change and motivational interviewing **Intervention provider:** experimenter **Mode of delivery:** not face-to-face **Time of delivery:** during CR **Intervention intensity:** NR

	Intervention target: patient **Materials provided:** logbook and an educational package with weekly topics **Tailoring:** NR **CR setting:** hybrid
Outcomes	Adherence - defined as per cent attendance at prescribed sessions
Notes	**Sponsorship source:** NR If, during this period, staff considered the participant more suitable for the standard CR programme for safety reasons, or if the participant decided that he/she preferred to be in the standard CR programme, an exit strategy was applied. A total of 4 participants who were randomized to the reduced CR programme used the exit strategy

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "participants were stratified by gender and randomized using a computer-generated block randomization (blocks of four, six and eight). Randomization by this procedure ensured that at the end of each block, an equal number of participants were assigned to each group. This block list was incorporated into a telephone randomization system"
Allocation concealment (selection bias)	Low risk	Quote: "participants were advised that due to the randomization process, they would not know which group they would be assigned to prior to giving consent; therefore, if one or both groups of the study were unacceptable to them for any reason, they were advised not participate"
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Exercise capacity and IHD risk factors were measured by technicians who were blinded to group randomization. Although the study manager and participants were aware of group assignments, the primary and many secondary outcomes were measured by blinded third parties"
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	Low risk	The dissertation is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way

Other bias	Low risk	The study appears to be free of other sources of bias

Focht 2004

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** NR
Participants	**Inclusion criteria:** older adults between 50 and 80 years of age; documented MI, PCI, chronic stable angina, stable HF, or cardiovascular surgery (coronary artery or valvular heart disease) in the past 6 months; self-reported disability and not actively engaging in exercise or CR for preceding 6 months **Exclusion criteria:** psychiatric illness (major depression within past 5 years); severe symptomatic heart disease (unstable angina, unstable HF, or exercise-induced complex ventricular arrhythmias); severe systemic disease; active treatment for cancer; hearing or sight impairment; alcoholism; inability to speak or read English; judgement of clinical staff; current participation in another medical intervention study **N randomized:** total: 147; intervention: 73; comparator: 74 **N lost to follow-up:** total: 5; intervention: 5; comparator: 0 **N analysed:** total: 142; intervention: 68; comparator: 74 **Age (mean ± SD):** intervention: 64.7 ± 7.2; comparator: 64.9 ± 6.8 **Sex (% women):** intervention: 45.2%; comparator: 50.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** group-delivered cognitive–behavioural physical activity programme, designed to gradually wean participants from dependency on the CR staff and group programme toward

	independent self-regulation of physical activity. For the first and second months, participants engaged in centre-based CR 2 times each week. During the third month, centre-based training was reduced to 1 time per week. In each of these months, self-planned home-based activity by participants provided additional sessions of exercise for a frequency equivalent to control treatment. Following each exercise therapy session, participants engaged in a 20- to 25-minute period of instruction and discussion regarding learning and using self-regulatory tools to maintain long-term physical activity **Comparison:** participants received 3 months of centre-based CR 3 days/week. In addition to exercise therapy, weekly educational lectures were given on topics that related to modification of risk factors for cardiovascular disease **Theoretical basis:** social-cognitive theory **Intervention provider:** certified exercise leaders **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 3 contacts **Intervention target:** patient **Materials provided:** NA **Tailoring:** NR **CR setting:** hybrid
Outcomes	Adherence - defined as percentage of the total number of sessions attended during the first 3 months of the trial Completion - defined as the number completing the CR programme and follow-up assessment
Notes	**Sponsorship source:** grants from the National Institutes for Aging AG14131 and 5P60 AG10484, and General Clinical Research Center Grant M01–RR007122

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"a randomized block design was used with stratification by gender"
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". The method of concealment was not described
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	Low risk	All relevant outcomes described in the methods were reported
Other bias	Low risk	The study appears to be free of other sources of bias

Grace 2016

Methods	**Study design:** RCT parallel - 3 arms **Country:** Canada **Date patients recruited:** November 2009 to July 2013
Participants	**Inclusion criteria:** women residing in proximity to CR programmes; proficiency in the English language; written approval to participate in CR provided by the patient's cardiac specialist or general practitioner (in the case of inpatient recruitment); eligibility for home-based CR (i.e. low to moderate risk as demonstrated by (1) lack of complex ventricular dysrhythmia, (2) NYHA class of 1 or 2 and left ventricular ejection fraction (LVEF) > 40%, or (3) CCS class 1 or 2) **Exclusion criteria:** musculoskeletal, neuromuscular, visual, cognitive, or non-dysphoric psychiatric condition; any serious or terminal illness not otherwise specified that would preclude CR eligibility based on CR guidelines; physician deemed patient not suitable for CR at time of intake exercise stress test (i.e. < 3 minutes completed on Bruce protocol treadmill stress test, or < 6 minutes on modified Bruce protocol treadmill stress test, or workload < 300 kpm on a cycle ergometer test, or significant ST segment depression, uncontrolled dysrhythmias, abnormal heart rate or blood pressure measurements in response to exercise); planning to leave the area before the anticipated end of the study; being discharged to a long-term care facility; previous participation in CR; participation in another clinical

	trial with behavioural interventions; in the case of inpatient recruitment, having been referred to a CR programme by their healthcare provider before study randomization was completed **N randomized:** total: 169; women-only CR: 55; home-based CR: 55; traditional mixed-sex CR: 59 **N lost to follow-up:** total: 101; women-only CR: 34; home-based CR: 37; traditional mixed-sex CR: 30 **N analysed:** total: 58; women-only CR: 21; home-based CR: 18; traditional mixed-sex CR: 19 **Age (mean ± SD):** women-only: 66.2 ± 10.2; home-based: 63.1 ± 10.9; mixed-sex comparator: 61.5 ± 9.7 **Sex (% women):** women-only: 100.0%; home-based: 100.0%; comparator: 100.0% **Race/ethnicity (% white):** women-only: 59.1%; home-based: 65.3%; comparator: 62.7%
Interventions	**Intervention:** women-only or home-based CR **Comparison:** traditional hospital-based mixed-sex CR. The only differences between site-based programme models were sex composition and some educational session content **Theoretical basis:** NA **Intervention provider:** NA **Mode of delivery:** not face-to-face **Time of delivery:** during CR **Intervention intensity:** NA **Intervention target:** patient **Materials provided:** NR

	Tailoring: NR **CR setting:** women-only: supervised; home-based: unsupervised; comparator: supervised
Outcomes	Enrolment - defined as patient attendance at first CR programme visit Adherence - defined as percentage of prescribed sessions attended Completion - defined as attended at least some of the CR intervention components and underwent formal re-assessment by the CR team at the conclusion of the CR intervention
Notes	**Sponsorship source:** funded by the Heart and Stroke Foundation of Ontario (Grant in Aid no. NA 6682) CR4HER trial

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The randomization sequence was computer- generated, in blocks of 6, and stratified by condition (myocardial infarction/percutaneous coronary intervention or coronary artery disease/coronary artery bypass graft and/or valve surgery) through randomize.net"
Allocation concealment (selection bias)	Low risk	Quote: "allocation concealed"
Blinding of outcome assessment (detection bias)	Low risk	Quote: "A masked research assistant then extracted these data from the CR program charts to calculate adherence"
Incomplete outcome data (attrition bias)	Low risk	Reasons for attrition and loss to follow-up were reported
Selective reporting (reporting bias)	Low risk	Grant proposal was secured from primary author, and all 3 outcomes were provided for this review
Other bias	High risk	Some participants switched treatment groups, and this may have introduced bias

Hwang 2017

Methods	**Study design:** RCT parallel - 2 arms

	Country: Australia **Date patients recruited:** July 2013 to February 2016
Participants	**Inclusion criteria:** HF, over 18 years of age **Exclusion criteria:** did not meet safety screening criteria as outlined by the Australian exercise guidelines for patients with chronic HF, such as symptomatic severe aortic stenosis and significant ischaemia at low exercise intensity; lived in an institution such as a nursing home; lived more than an hour driving distance from the treating hospital; had no support person at home **N randomized:** total: 53; intervention: 24; comparator: 29 **N lost to follow-up:** total: 4; intervention: 1; comparator: 3 (6 months' follow-up) **N analysed:** total: 102; intervention: 23; comparator: 26 **Age (mean ± SD):** intervention: 68.0 ± 14.0; comparator: 67.0 ± 11.0 **Sex (% women):** intervention: 20.8%; comparator: 27.5% **Race/ethnicity (% white):** intervention: 92%; comparator: 93%
Interventions	**Intervention:** short-term, real-time, group-based HF rehabilitation programme delivered at each participant's home via an online telerehabilitation system. The programme was delivered via a synchronous videoconferencing platform across the Internet to groups of up to 4 participants within the home. Two-way audiovisual communication enabled interaction of all parties, and the physiotherapist guided participants through an exercise programme similar to the control. This approach enabled the physiotherapist to watch participants performing the exercises and to provide real-time feedback and modification, as required, as well as to facilitate peer support from other participants. Participants were provided with additional home exercises similar to those in the control group. Participants were encouraged to watch the designated presentation individually or with their support person, in their own time, in preparation for subsequent online group discussions. A 15-minute interaction period was held at the start of each telerehabilitation session to facilitate these discussions **Comparison:** the control group received a centre-based rehabilitation programme based on current recommended guidelines encompassing education, aerobics, and strength training exercise. This traditional HF rehabilitation programme was led by physiotherapists over a 12-week period; it consisted

	of 60 minutes of exercise per session, 2 sessions per week, at the treating hospital. Each session consisted of a 10-minute warm-up, 40 minutes of aerobic and strength exercises, and a 10-minute cool-down. Exercise prescription was tailored to the participant's goal, and the treating physiotherapist continuously reviewed it to ensure appropriate progression. The control group attended educational sessions at the hospital on the same day as the exercise sessions **Theoretical basis:** NR **Intervention provide**r: NA **Mode of delivery:** not face-to-face **Time of delivery:** during CR **Intervention intensity:** NA **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** unsupervised
Outcomes	Adherence - defined on basis of the proportion of prescribed sessions attended (in person or online)
Notes	**Sponsorship source:** supported by the Princess Alexandra Hospital Research Support Scheme Small Grant 2013; the Prince Charles Hospital Foundation Novice

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were allocated 1:1 using a non-blocked random allocation sequence" Information regarding sequence generation was insufficient to permit judgement of risk
Allocation concealment (selection bias)	Low risk	Quote: "Allocation was concealed through the use of opaque, sealed and numbered

		envelopes, and administered by an experienced, independent researcher at a central location"
Blinding of outcome assessment (detection bias)	Low risk	Quote: "blinded outcome assessors"
Incomplete outcome data (attrition bias)	Low risk	Reasons for exclusion and losses to follow-up were reported
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol is not available to identify unreported outcomes
Other bias	Low risk	The study appears to be free of other sources of bias

Jolly 1999

Methods	**Study design:** RCT cluster **Country:** UK **Date patients recruited:** NR
Participants	**Inclusion criteria:** patients admitted to hospital with MI or with angina of recent onset seen in hospital from 1 of 67 general practices in a specified geographical area; patients judged well enough to participate by medical and nursing staff on the ward or in the clinic **Exclusion criteria:** NR **N randomized:** total: 597; intervention: 277; comparator: 320 **N lost to follow-up:** total: 38; intervention: 15; comparator: 23 (12 months' follow-up) **N analysed:** total: 559; intervention: 262; comparator: 297 **Age (mean ± SD):** intervention: 63.0 ± 10.0; comparator: 64.0 ± 10.0 **Sex (% women):** intervention: 32.0%; comparator: 26.0% **Race/ethnicity (% white):** NR

Interventions	**Intervention:** specialist cardiac liaison nurses co-ordinated the transfer of participant care between hospital and general practice. The liaison nurse saw participants in hospital and encouraged them to see a practice nurse after discharge. Each participant was given a patient-held record card that prompted and guided follow-up at standard intervals. Support was provided to practice nurses by regular contact, including a telephone call shortly before participant discharge to discuss care and book at first follow-up visit to the practice. Practice nurses were encouraged to telephone the liaison nurse to discuss problems or to seek advice on clinical and organisational issues **Comparison:** usual care without care co-ordination **Theoretical basis:** NR **Intervention provider:** nurse **Mode of delivery:** face-to-face **Time of delivery:** pre-CR **Intervention intensity:** 1 **Intervention target:** nurse **Materials provided:** NA **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined as attendance at at least 1 CR session
Notes	**Sponsorship source:** funded by a research and development national programme grant from the NHS Executive, with service support from Southampton and South West Hampshire Health Authority

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of outcome assessment (detection bias)	Low risk	Follow-up of participants carried out by a nurse not responsible for delivering the intervention to the participant's practice
Incomplete outcome data (attrition bias)	Low risk	10% of participants lost to follow-up; similar rates for intervention arm and control arm
Selective reporting (reporting bias)	Low risk	The protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

Kraal 2014

Methods	**Study design:** RCT parallel - 2 arms **Country:** the Netherlands **Date patients recruited:** March 2013 to March 2014
Participants	**Inclusion criteria:** patients who entered CR after hospitalization for MI, unstable angina, or a revascularization procedure (PCI or CABG); low to moderate risk of future cardiac events according to the Dutch CR guidelines **Exclusion criteria:** NR **N randomized:** total: 55; intervention: 29; comparator: 26 **N lost to follow-up:** total: 5; intervention: 4; comparator: 1 **N analysed:** total: 50; intervention: 25; comparator: 25 **Age (mean ± SD):** intervention: 60.6 ± 7.5; comparator: 56.1 ± 8.7

	Sex (% women): intervention: 12.0%; comparator: 16.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** the FIT@HOME intervention combined motivational interviewing in the initial CR phase with ongoing objective feedback on training progression. After 3 supervised training sessions in the outpatient clinic, participants started training in their home environment. The coach remotely supervised the training sessions performed at home and offered appropriate support via telephone using a semi-structured interview **Comparison:** group-based training sessions on a treadmill or cycle ergometer, supervised by physical therapists and exercise specialists. The programme lasted for 12 weeks, with at least 2 training sessions per week. Participants were instructed to exercise for 45 to 60 minutes per session at 70% to 85% of their maximal heart rate **Theoretical basis:** behavioural change (goal-setting and motivational interviewing) **Intervention provider:** NA **Mode of delivery:** not face-to-face **Time of delivery:** during CR **Intervention intensity:** NA **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** hybrid
Outcomes	Adherence - defined as percentage of prescribed sessions completed
Notes	**Sponsorship source:** funded by ZonMw, the Dutch Organisation for Health Research and Development (project number 837001003)

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Allocation was based on randomization with variable block size (2 or 4) performed with dedicated computer software by a researcher who was not present at the time of allocation
Allocation concealment (selection bias)	Low risk	To conceal allocation, numbered and sealed opaque envelopes were opened between the baseline cardiopulmonary exercise test and the start of exercise training
Blinding of outcome assessment (detection bias)	Low risk	No information for the outcome of interest was provided; however the outcome measurement is not likely to be influenced by lack of blinding
Incomplete outcome data (attrition bias)	High risk	29 and 26 participants were randomized, but the study provided data for 25 participants in each arm, suggesting missing outcome data
Selective reporting (reporting bias)	Low risk	All outcomes described in the protocol were reported - although through different publications (cost analysis was published in a different article)
Other bias	Low risk	Groups were comparable at baseline, including all major prognostic factors. The study appears to be free of other sources of bias

Lynggaard 2017

Methods	**Study design:** RCT parallel - 2 arms **Country:** the Netherlands **Date patients recruited:** November 2010 to December 2012
Participants	**Inclusion criteria:** aged 18 years and older, discharged from hospital with ischaemic heart disease or HF; assigned and motivated for CR **Exclusion criteria:** acute coronary syndrome less than 5 days before randomization; active peri-, myo-, or endocarditis; symptomatic and untreated valve disease; severe hypertension with blood pressure > 200/110 mmHg; other severe cardiac or extracardiac disease; planned revascularization; senile dementia; assessed as having low compliance; former participation in the study **N randomized:** total: 825; intervention: 413; comparator: 412

	N lost to follow-up: total: 8; intervention: 4; comparator: 4 **N analysed:** total: 825; intervention: 413; comparator: 412 **Age (mean ± SD):** intervention: 63.0 ± 10.0; comparator: 63.0 ± 11.0 **Sex (% women):** intervention: 24.0%; comparator: 24.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** based on learning and coping strategies. The intervention group received individual clarifying interviews before and after the CR programmes. Participants had an initial interview to help clarify their needs before CR and to prepare them to learn how to cope with living with a chronic heart disease. In the finishing interview, the patient and the health professional in partnership clarified what benefits the patient had derived from CR and discussed future strategies for coping with their chronic heart disease. Narratives told by experienced patients were used as good learning examples **Comparison:** the control group received group-based CR lasting 8 weeks, with exercise training sessions 3 times a week and education once a week **Theoretical basis:** learning and coping - Illness perception, use of narratives, appreciative approach **Intervention provider:** nurse, physiotherapist, and experienced former CR patients (co-educators and narrators). Each week, a 1-hour evaluation meeting was held by the nurse, the physiotherapist, and the experienced patient assigned to each specific class **Mode of delivery:** face-to-face **Time of delivery:** pre-CR and post-CR **Intervention intensity:** 2 **Intervention target:** patient **Materials provided:** NR

	Tailoring: NR **CR setting:** supervised
Outcomes	Adherence - defined as percentage of prescribed sessions completed
Notes	**Sponsorship source:** funded by the Danish Ministry of Health (54804/22), the Health Research Fund of Central Denmark Region, and the Danish Foundation

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "blocks of two to four using a web-based system that was implemented independently of the research team"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of outcome assessment (detection bias)	Unclear risk	Quote: "it was not possible to blind patients or health professionals. However, as the primary adherence outcomes were assessed objectively, it is unlikely to be subject to patient reporting bias"
Incomplete outcome data (attrition bias)	Low risk	Reasons for exclusion and losses to follow-up were reported; intention-to-treat analysis was performed
Selective reporting (reporting bias)	Low risk	The protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

McGrady 2014

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** NR
Participants	**Inclusion criteria:** patients admitted to Phase II of the CR after MI, CABG surgery, stable angina, chronic heart failure (CHF, NYHA class I or II), or other procedure (stent placement, valve replacements, aortic aneurism repair, atrial fibrillation, and heart transplant)

	Exclusion criteria: NR **N randomized:** total: 304; intervention: 136; comparator: 168 **N lost to follow-up:** NR **N analysed:** total: 304; intervention: 136; comparator: 168 **Age (mean ± SD):** intervention: 60.3 ± 11.7; comparator: 62.8 ± 13.1 **Sex (% women):** intervention: 34.0%; comparator: NR **Race/ethnicity (% white):** NR
Interventions	**Intervention:** the intervention consisted of four 30-minute sessions conducted during the first weeks of CR. Participants participated in groups of 2 to 6. Sessions rotated so that a participant could begin at any time in the 4 sessions. Each session consisted of about 15 minutes of motivational interviewing and about 15 minutes of relaxation. The motivational interviewing portions focussed on participants' personal goals, fostering an optimistic view of the benefits of rehabilitation, decreasing negative self-talk, and overcoming barriers to completing the exercise programme. The relaxation portion comprised mindful breathing, progressive relaxation, and simple imagery **Comparison:** the historical control group received group-based CR lasting 12 weeks, with exercise training sessions 3 times a week and education once a week **Theoretical basis:** NA **Intervention provider:** nurse, physiotherapist, and experienced former CR patients (co-educators and narrators). Each week, a 1-hour evaluation meeting was held by the nurse, the physiotherapist, and the experienced patient assigned to each specific class **Mode of delivery:** face-to-face **Time of delivery:** during CR

	Intervention intensity: 4 **Intervention target:** patient **Materials provided:** handouts for each relaxation technique were provided to all attendees; practice was encouraged but was not formally monitored **Tailoring:** NR **CR setting:** supervised
Outcomes	Adherence - defined as percentage of prescribed sessions completed
Notes	**Sponsorship source:** NR

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	High risk	Table 4 shows baseline scores for completers and non-completers of the intervention; however dropout reasons were not stated
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol or trial register is not available to identify unreported outcomes
Other bias	Unclear risk	Whether comparison groups were similar at baseline remains unclear

McPaul 2007

Methods	**Study design:** RCT parallel - 2 arms **Country:** United Kingdom **Date patients recruited:** December 2006 to June 2007

Participants	**Inclusion criteria:** non-ST elevation MI **Exclusion criteria:** patients considered mentally unable to complete a questionnaire (e.g. due to dementia or mental handicap) or considered too ill to be asked to participate; those living too far away to be visited at home; those with a known history of violence because they may have been a threat to the researcher visiting them at home; prisoners due to their lack of freedom to decide for themselves whether or not to attend; those who died, were discharged, or were transferred to another hospital **N randomized:** total: 25; intervention: 15; comparator: 10 **N lost to follow-up:** total: 4; intervention: 3; comparator: 1 **N analysed:** total: 21; intervention: 12; comparator: 9 **Age (mean ± SD):** overall: 67.2 ± 13.9 **Sex (% women):** overall: 16.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** a home visit by the researcher to the participant (and relative if required) with a semi-structured discussion format used during the visit. The visit started with a general discussion about the participant's physical and mental health since hospital discharge. Counselling was provided about appropriate level of physical activity, medications, diet, and smoking cessation. The researcher invited the participant to attend and encouraged participation in CR **Comparison:** a telephone call using the same semi-structured interview format; participants were invited to attend CR and were invited to attend a pre-CR clinic **Theoretical basis:** NR **Intervention provider:** allied healthcare provider (occupational therapist) **Mode of delivery:** face-to-face **Time of delivery:** pre-CR

	Intervention intensity: 1 **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** supervised
Outcomes	Enrolment - defined as attendance at CR
Notes	**Sponsorship source:** funded by Epsom and St Helier NHS Trust All control participants who attended the pre-CR clinic attended CR later

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Envelopes allocating to intervention or treatment were randomly arranged by the researcher
Allocation concealment (selection bias)	Low risk	Sealed envelopes were used
Blinding of outcome assessment (detection bias)	High risk	Study personnel were not blinded
Incomplete outcome data (attrition bias)	Unclear risk	4 participants were lost to follow-up and excluded from analysis. Analyses were based on the 21 participants who completed the study. ITT analyses were not performed
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol is not available to identify unreported outcomes
Other bias	Unclear risk	No significant differences were noted in baseline measurements of anxiety and depression, but information on major cardiovascular risk factors was not collected

Mosleh 2014

Methods	**Study design:** RCT parallel - 4 arms

	Country: Israel **Date patients recruited:** January 2007 to December 2007
Participants	**Inclusion criteria:** patients admitted with MI, CABG, or PCI and referred to hospital-based CR programme or to 1 of the 3 community CR programmes **Exclusion criteria:** terminal illness, arrhythmia, alcohol or drug abuse, mental or physical disability **N randomized:** total: 375; intervention 1 (theory-based letter): 96; intervention 2 (standard letter + leaflet): 92; intervention 3 (theory-based letter + leaflet): 91; comparator (standard letter): 96 **N lost to follow-up:** none **N analysed:** total: 375; intervention 1 (theory-based letter): 96; intervention 2 (standard letter + leaflet): 92; intervention 3 (theory-based letter + leaflet): 91; comparator (standard letter): 96 **Age (mean ± SD):** intervention 1: 60.3 ± 12.5; intervention 2: 63.4 ± 10.3; intervention 3: 63.2 ± 11.3; comparator: 63.0 ± 10.3 **Sex (% women):** intervention 1: 29.1%; intervention 2: 33.5%; intervention 3: 32.6%; comparator: 33.3% **Race/ethnicity (% white):** NR
Interventions	**Interventions:** 2 postal interventions to increase attendance at CR. An invitation letter and a supportive leaflet were both developed in accordance with theories. The CR programme secretary posted the standard letter or the new letter, with or without the supplementary leaflet (according to group allocation), to the participant's home address 2 weeks before the participant was due to attend outpatient CR. The leaflet included instructions that it should be read the day before the participant's first appointment **Comparator:** received a standard letter of invitation to attend CR; as per usual practice, participants in all groups received a telephone call to encourage attendance **Theoretical basis:** theory of planned behaviour and commonsense model of illness

	Intervention provider: not a healthcare provider or nurse **Mode of delivery:** mail **Time of delivery:** pre-CR **Intervention intensity:** 1 or 2 **Intervention target:** patient **Materials provided:** letter and leaflet about the benefits of CR **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined as patient attendance at 1 or more biweekly sessions
Notes	**Sponsorship source:** no specific grant from any funding agency in the public, commercial, or not-for-profit sector

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "An independent statistician randomly allocated a list of ID numbers into four groups and provided this to the CR secretary, who posted the appropriate invitation letter plus or minus the leaflet according to the allocation"
Allocation concealment (selection bias)	Low risk	Quote: "Details of which participants were allocated to which groups were released to the researcher and the researcher's advisors after all participants had completed the eight-week outpatient CR program and data collection was complete. In addition, the CR secretary kept the allocation schedule secure from the other CR staff in a computerized locked file"
Blinding of outcome assessment (detection bias)	Low risk	Quote: "The researchers were kept blind to group allocation"
Incomplete outcome data (attrition bias)	Low risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	Low risk	The protocol is available, and all of the study's prespecified (primary and secondary)

		outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias; groups were comparable at baseline

Oldridge 1983

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Date patients recruited:** NR
Participants	**Inclusion criteria:** all male patients admitted with a documented diagnosis of coronary heart disease (MI, CABG, and angina) and referred to CR **Exclusion criteria:** NR **N randomized:** total: 120; intervention: 63; comparator: 57 **N lost to follow-up:** none **N analysed:** total: 120; intervention: 63; comparator: 57 **Age (mean ± SD):** overall: 51.5 ± 8.7 **Sex (% women):** 0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** usual comprehensive CR programme plus self-management techniques, including an agreement to participate in the programme for 6 months to be signed by the participant and the co-ordinator, and self-report diaries to be completed and discussed with the co-ordinator at regular intervals. Diaries included 6 graphs for plotting self-monitored submaximal heart rates each month, at 33%, 50%, and 75% of the maximum power output achieved in the previous exercise test, and 6 × 24-hour recall questionnaires of daily activities on a randomly chosen day to be completed each month. In addition, a weight loss diary to be filled in each week was given to participants who initially agreed to lose weight, and similar diaries were used to record the number of cigarettes smoked each day (as

	applicable). Follow-up was provided at the end of the intervention period of 6 months **Comparison:** usual comprehensive CR programme **Theoretical basis:** self-management **Intervention provider:** physician and exercise leaders **Mode of delivery:** face-to-face **Time of delivery:** during CR **Intervention intensity:** 1 **Intervention target:** patient **Materials provided:** contract, diaries, logs **Tailoring:** NR **CR setting:** supervised
Outcomes	Completion - defined as percentage of those who attended 60% or more of the 48 scheduled supervised CR sessions
Notes	**Sponsorship source:** Health and Welfare, Canada, National Health Research and Development Program, grant 6606-1586-44 Participants were stratified by smoking status, occupation, leisure habits, and number of prior infarctions before randomization. These variables were shown to be predictors of dropout

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number list was used

Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of outcome assessment (detection bias)	Unclear risk	Not reported
Incomplete outcome data (attrition bias)	Unclear risk	Attendance of dropouts was similar in intervention and control groups (21% with intervention vs 16% with control) and was also similar for compliers (74% with intervention vs 76% with control). Not all participants in the intervention group signed the agreement to participate. Compliance was significantly higher among the 48 people who signed (65%) than in the 15 who refused to sign (20%)
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol is not available to identify unreported outcomes
Other bias	Unclear risk	Whether comparison groups were similar at baseline remains unclear

Pack 2013

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** February 2011 to November 2011
Participants	**Inclusion criteria:** patients > 18 years of age with a qualifying diagnosis for referral to CR (MI, PCI, or angina with an ischaemic stress ECG, stress echocardiogram, or stress myocardial perfusion imaging study) **Exclusion criteria:** patients who had undergone recent CABG, valve surgery, or cardiac transplantation **N randomized:** total: 150; intervention: 76; comparator: 74 **N lost to follow-up:** total: 2; intervention: 2; comparator: 0 **N analysed:** total: 148; intervention: 74; comparator: 74 (for attendance) **Age (mean ± SD):** intervention: 61.0 ± 12.0; comparator: 59.0 ± 12.0 **Sex (% women):** intervention: 39.2%; comparator: 50.0%

	Race/ethnicity (% white): intervention: 45.0%; comparator: 42.0%
Interventions	**Intervention:** early appointment for orientation class for CR (within 10 days) **Comparison:** participants randomized to standard care were scheduled for an orientation appointment within 35 days from the index event **Theoretical basis:** NR **Intervention provider:** NA **Mode of delivery:** not face-to-face **Time of delivery:** pre-CR **Intervention intensity:** NR **Intervention target:** patient **Materials provided:** NA **Tailoring:** NR **CR setting:** supervised
Outcomes	Enrolment - defined as attendance at orientation class for CR Adherence - defined as total number of exercise sessions attended Completion - defined as completion of CR
Notes	**Sponsorship source:** funding for statistical analysis came from the Department of Graduate Medical Education at Henry Ford Hospital Study was terminated early due to relocation of the trial principal investigator. An unplanned interim analysis revealed a statistically significant difference in attendance rate for CR, so recruitment was terminated early

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Sequence generation was created via a computerised random number generator
Allocation concealment (selection bias)	Low risk	Allocation cards were kept in opaque sequential sealed envelopes until the time of participant randomization
Blinding of outcome assessment (detection bias)	High risk	CR staff recorded primary outcomes and were not blinded to treatment allocation
Incomplete outcome data (attrition bias)	Low risk	2 participants in the intervention group withdrew consent and were excluded; they were treated as non-attenders in analyses; ITT analysis was performed
Selective reporting (reporting bias)	Low risk	All relevant outcomes described in the methods were reported
Other bias	Unclear risk	Trial was terminated early due to unplanned interim analysis

Parry 2009

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Dates patients recruited:** February 2006 to February 2007
Participants	**Inclusion criteria:** men and women having first-time non-emergency CABG surgery, ready for discharge home, and able to communicate via telephone **Exclusion criteria:** NR **N randomized:** total: 101; intervention: 49; comparator: 52 **N lost to follow-up:** total: 7; intervention: 5; comparator: 2 **N analysed:** total: 95; intervention: 45; comparator: 50

	Age (mean ± SD): intervention: 62.0±11.0; comparator: 64.0±10.0 **Sex (% women):** intervention: 16.3%; comparator: 17.3% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** participants received peer-generated telephone calls for 8 weeks following hospital discharge. Telephone calls focussed on pain management, exercise, and encouragement to enroll in a CR programme. Dose and frequency of calls were determined by peer-patient dyad, and most telephone calls were peer-initiated **Comparison:** usual care consisted of standard preoperative and postoperative education and visits from in-hospital peer volunteers **Theoretical basis:** NR **Intervention provider:** peer volunteers included men and women who had undergone CABG surgery within the previous 5 years and had attended a CR programme. Peer volunteers attended a 4-hour training session to develop skills required for effective telephone support. Peer volunteers received a training manual intended to guide the training sessions and the intervention **Mode of delivery:** not face-to-face **Time of delivery:** pre-CR **Intervention intensity:** 12 **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined as attendance at at least 1 session
Notes	**Sponsorship source:** Heart and Stroke Foundation of Canada, Canadian Institutes of Health Research FUTURE Program for Cardiovascular Nurse Scientists, Cardiac Science Medtronic Research

	Grant/Kingston General Hospital, Canadian Council of Cardiovascular Nurses Research Grant, Nurse Practitioner Association of Ontario Cardiovascular Acute Care Nurse Practitioner Pfizer Award, and a Canadian Pain Society Nursing Research Award A wide range in the number of contacts, as well as in time per contact, was evident. Only 17 (18%) participants attended CR at 9 weeks post surgery

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random assignment was centrally controlled by an Internet-based randomization service, with stratification based on sex and variable block sizes of 4 and 8
Allocation concealment (selection bias)	Low risk	Centralised randomization was performed
Blinding of outcome assessment (detection bias)	Low risk	Outcome data were collected via telephone interview by a research assistant blinded to group allocation
Incomplete outcome data (attrition bias)	Unclear risk	6 dropouts were balanced between intervention and control arms. Unclear whether ITT analysis was performed. Text refers to "intention to treat analyses", but figure suggests that excluded participants were not included in the analyses
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol is not available to identify unreported outcomes
Other bias	Low risk	The study appears to be free of other sources of bias

Pfaeffli Dale 2015

Methods	**Study design:** RCT parallel - 2 arms **Country:** New Zealand **Date patients recruited:** recruited over 10 months between 2013 and 2014
Participants	**Inclusion criteria:** English-speaking adults with a documented diagnosis of CHD (MI, angina, or revascularization). Although participants were not required to have computer or Internet literacy, access to the Internet (e.g. at home, work, or library) was a requirement. Participants need not own a mobile phone with text messaging capability because phones were supplied for the duration of the study if

	necessary **Exclusion criteria:** those with untreated ventricular tachycardia, severe HF, life-threatening coexisting disease with life expectancy less than 1 year, and/or significant exercise limitations for reasons other than CHD **N randomized:** total: 123; intervention: 61; comparator: 62 **N lost to follow-up:** none **N analysed:** total: 123; intervention: 61; comparator: 62 **Age (mean ± SD):** intervention: 59.0 ± 10.5; comparator: 59.9 ± 11.8 **Sex (% women):** intervention: 21.0%; comparator: 16.0% **Race/ethnicity (% white):** intervention: 75%; comparator: 73%
Interventions	**Intervention:** a theoretically framed comprehensive programme of evidence-based CR. The intervention group received a 24-week mHealth programme sent by automated daily text messages and access to a supporting website commencing within a week of the baseline assessment. The aim was to mirror current CR programmes in educating participants about their cardiovascular risk factors and in supporting them to make relevant lifestyle changes Additionally, they received usual care, which included inpatient rehabilitation and encouragement to attend centre-based CR. Traditional CR offered at hospital recruiting sites consisted of one 1-hour outpatient educational programme per week for 6 weeks at a hospital or community centre, covering a range of topics, including cardiovascular risk factors, lifestyle change, and psychosocial support. Participants also were encouraged to attend a 16-session supervised exercise programme at the participating hospital or outpatient centre **Comparison:** usual care group received inpatient rehabilitation and encouragement to attend centre-based CR **Theoretical basis:** social cognitive theory

	Intervention provider: NA **Mode of delivery:** not face-to-face **Time of delivery:** during CR **Intervention intensity:** 144 **Intervention target:** patient **Materials provided:** NR **Tailoring:** messages were tailored to participants' names and preferred times of day to receive messages **CR setting:** supervised
Outcomes	Enrolment - defined as having attended at least 1 session of usual care CR
Notes	**Sponsorship source:** funded in part by a Health Research Council Sir Charles Hercus Fellowship and a HOPE Selwyn Foundation Scholarship in Ageing Research

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The randomization sequence was computer generated by a statistician independent to the project using a block size of 6"
Allocation concealment (selection bias)	Low risk	Allocation was concealed in sequentially numbered, opaque, sealed envelopes
Blinding of outcome assessment (detection bias)	High risk	Quote: "Because of the nature of the intervention, participants and outcome assessors were not blinded to their treatment allocation"
Incomplete outcome data (attrition bias)	Low risk	Reasons for exclusion and losses to follow-up were reported; intention-to-treat analysis was not performed
Selective reporting (reporting bias)	Low risk	The study protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

Price 2012

Methods	**Study design:** RCT parallel - 2 arms **Country:** Canada **Date patients recruited:** NR
Participants	**Inclusion criteria:** female patients who were hospitalised for a cardiac diagnosis (MI, angina, HF, CABG, CABG/valve or valve surgery, or PCI); were eligible for referral to CR; were judged ready for discharge; had access to and were able to communicate over a telephone; and were able to read, write, and understand English **Exclusion criteria:** NR **N randomized:** total: 70; intervention: 34; comparator: 36 **N lost to follow-up:** total: 4; intervention: 1; comparator: 3 **N analysed:** total: 66; intervention: 33; comparator: 33 **Age (mean ± SD):** intervention: 67.0 ± 12.0; comparator: 68.0 ± 11.0 **Sex (% women):** intervention: 100.0%; comparator: 100.0% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** usual care plus an individualised personal coaching programme. The coaching programme consisted of scheduled, coach-generated telephone calls between hospital discharge and CR intake appointment to explain the benefits of CR, clarify concerns, motivate women to enrol, and overcome any individual barriers to entering a programme. Coaching emphasised problem-solving, decision-making, and confidence-building. Intervention calls were initiated within 1 to 2 weeks of hospital discharge. They were scheduled every 2 weeks, with at least 3 telephone calls completed, or the participant attended an intake appointment **Comparison:** usual care consisted of a referral to CR followed by a letter from the programme informing the participant of his or her intake appointment

	Intervention provider: nurse **Mode of delivery:** telephone call **Time of delivery:** Pre-CR **Theoretical basis:** social cognitive theory **Intervention intensity:** 5 contacts **Intervention target:** patient **Materials provided:** NR **Tailoring:** NR **CR setting:** supervised
Outcomes	Enrolment - defined as attendance at the initial CR appointment
Notes	**Sponsorship source:** funded by Heart and Stroke Foundation of Canada, FUTURE Program for Cardiovascular Nurse Scientists, Canadian Council of Cardiovascular Nursing Research Grant, Sunnybrook and Women's Health Science's Nursing Graduate Award, and the Jesse Young Award from Women's College Hospital and the Academic Cardiology Group at Women's College Hospital

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomization was centrally controlled by a Web-based randomization service
Allocation concealment (selection bias)	Low risk	The primary investigator and participants were unaware of the next assignment in the randomization sequence
Blinding of outcome assessment (detection bias)	Low risk	The research assistant, blinded to group allocation, collected all outcome data
Incomplete outcome data (attrition bias)	Unclear risk	4 participants were lost to follow-up, and 4 discontinued/refused to complete. Analyses were described as ITT, but participants lost to follow-up were excluded from analyses

Selective reporting (reporting bias)	Low risk	The dissertation is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	Groups were comparable at baseline, including major prognostic factors

Suskin 2007

Methods	**Study design:** RCT parallel - 2 arms **Country:** USA **Date patients recruited:** May 2003 to October 2006
Participants	**Inclusion criteria:** patients admitted for MI, unstable angina, PCI, and CABG **Exclusion criteria:** NR **N randomized:** total: 548; intervention: 275; comparator: 273 **N lost to follow-up:** NR **N analysed:** total: 548; intervention: 275; comparator: 273 **Age (mean ± SD):** NR **Sex (% women):** intervention: 31.6%; comparator: 31.1% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** participants received a strong endorsement of CR through a pre-discharge personalised letter written by the attending cardiologist (or the cardiac surgeon), encouraging participation in CR. In addition to the standard CR referral, participants were given their CR programme intake appointment dates before hospital discharge **Comparison:** participants received a standard CR referral alone **Theoretical basis:** NR

	Intervention provider: doctor **Mode of delivery:** letter **Time of delivery:** pre-CR **Intervention intensity:** 1 contact **Intervention target:** patient **Materials provided:** letter encouraging CR attendance **Tailoring:** NR **CR setting:** NR
Outcomes	Enrolment - defined by attendance at the CR programme within 4 months of index hospital discharge
Notes	**Sponsorship source:** NR Abstract only

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Allocation concealment (selection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	Unclear risk	Reasons for withdrawal were provided
Selective reporting (reporting bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk". Study protocol is not available to identify unreported outcomes
Other bias	Unclear risk	Information was insufficient to assess whether an important risk of bias exists

Varnfield 2014

Methods	**Study design:** RCT parallel - 2 arms **Country:** Australia **Date patients recruited:** May 2009 to February 2011
Participants	**Inclusion criteria:** patients admitted for MI and referred to CR **Exclusion criteria:** unable to participate in self-management programmes or to operate smartphone for purposes of trial due to medical care needs (e.g. vision, hearing, cognitive or dexterity impairment); attending CR or involved in another behavioural trial; or had no experience with mobile/smartphones **N randomized:** total: 120; intervention: 60; comparator: 60 **N lost to follow-up:** total: 48; intervention: 14; comparator: 34 **N analysed:** total: 72; intervention: 46; comparator: 26 (6-week assessment) **Age (mean ± SD):** intervention: 54.9 ± 9.6; comparator: 56.2 ± 10.1 **Sex (% women):** intervention: 31.6%; comparator: 31.1% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** the CAP-CR platform used a smartphone for health and exercise monitoring, and delivered motivational and educational materials to participants via text messages and pre-installed audio and video files (including understanding cardiovascular disease, symptoms, and management). The platform included a Web portal with participant data for mentors to provide weekly consultations **Comparison:** community centres **Theoretical basis:** NR **Intervention provider:** technology; mentors on CAP-CR

	Mode of delivery: smartphone **Time of delivery:** during CR **Intervention intensity:** NR **Intervention target:** patient **Materials provided:** smartphone with all applications necessary for the CR intervention **Tailoring:** NR **CR setting:** unsupervised
Outcomes	Enrolment - defined as attending baseline assessment and at least 1 gym exercise session for the comparison group, and upload of exercise data to the Web portal for the CAP-CR group Adherence - defined as attendance for 4 weeks (8 or more gym sessions) for the traditional CR group, or upload of 4 weeks' exercise data for the CAP-CR group Completion - defined as completion of the 6-week CR programme
Notes	**Sponsorship source:** funding provided through a Joint Venture between Australian eHealth Research Centre and Queensland Health

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Permuted-block randomization, by computer-generated random numbers with variable block sizes of 4, 6 and 8"
Allocation concealment (selection bias)	Low risk	Quote: "sequentially numbered opaque, sealed envelopes, was conducted prior to baseline assessment to randomize patients to one of two parallel groups"
Blinding of outcome assessment (detection bias)	High risk	Quote: "unblinded randomized controlled trial"
Incomplete outcome data (attrition bias)	Low risk	Primary outcome measures of uptake and completion were analysed on an intention-to-

		treat basis. Adherence was assessed only among those who undertook the programme. Reasons for exclusion and losses to follow-up were reported
Selective reporting (reporting bias)	Low risk	The protocol is available, and all of the study's prespecified (primary and secondary) outcomes of interest in the review have been reported in the prespecified way
Other bias	Low risk	The study appears to be free of other sources of bias

Wyer 2001

Methods	**Study design:** RCT parallel - 2 arms **Country:** United Kingdom **Date patients recruited:** April 2000 to December 2000
Participants	**Inclusion criteria:** adult patients hospitalised for acute myocardial infarction and referred to a CR programme **Exclusion criteria:** NR **N randomized:** total: 87; intervention: 43; comparator: 44 **N lost to follow-up:** total: 19; intervention: 6; comparator: 13 **N analysed:** total: 68; intervention: 37; comparator: 31 **Age (mean):** intervention: 62.2; comparator: 63.3 **Sex (% women):** intervention: 13.9%; comparator: 11.3% **Race/ethnicity (% white):** NR
Interventions	**Intervention:** letters based on the theory of planned behaviour (Ajzen 1986) designed to increase attendance at outpatient CR clinic were given to participants 3 days post MI and were sent 3 weeks post MI. The first letter was designed to influence acceptance, and the second was designed to influence attendance. Participants also received a nominal letter of thanks at 3 days, and the standard letter detailing course dates was sent to control participants. After allocation to groups, the cardiac rehabilitation nurse saw all participants for routine assessment and personal invitation to the

	programme. For participants who declined the offer of a place, a brief second letter was sent to wish them well and to inform them that they were still welcome to contact the team **Comparison:** nominal letter of thanks given to participants at 3 days post MI along with the standard letter detailing course dates **Theoretical basis:** theory of planned behaviour **Intervention provider:** NA **Mode of delivery:** letter **Time of delivery:** pre-CR **Intervention intensity:** 2 contacts **Intervention target:** patient **Materials provided:** letters to increase attendance **Tailoring:** NR **CR setting:** unsupervised
Outcomes	Enrolment - defined as attendance at the outpatient CR programme
Notes	**Sponsorship source:** NR Women were less likely to attend the programme, but neither age nor distance lived from the programme predicted attendance. Study authors noted that the intervention may have worked by acting as a fear message, rather than through implementation of the theory of planned behaviour

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection	Low risk	Allocation was done by random number assignment

bias)		
Allocation concealment (selection bias)	Low risk	Participants were handed a sealed numbered envelope with a nominal letter. Half of the envelopes also contained an intervention letter. Envelope contents were known to a research assistant only
Blinding of outcome assessment (detection bias)	Unclear risk	Information was insufficient to permit judgement of "low risk" or "high risk"
Incomplete outcome data (attrition bias)	Unclear risk	13 participants were excluded but were not told treatment allocation
Selective reporting (reporting bias)	Low risk	Information was insufficient to permit judgement of "low risk" or "high risk". The study protocol is not available to identify unreported outcomes
Other bias	High risk	CR nurse was not aware of group assignments; however, no procedure was in place to stop participants from telling the nurse which letter they received

AACVPR: American Association of Cardiovascular and Pulmonary Rehabilitation; ACS: acute coronary syndrome; CABG: coronary artery bypass graft; CAP-CR: Care Assessment Platform-Cardiac Rehabilitation; CCS: Canadian Cardiovascular Society; CHD: coronary heart disease; CR: cardiac rehabilitation; ECG: electrocardiogram; HF: heart failure; IHD: ischaemic heart disease; ITT: intention-to-treat; LVEF: left ventricular ejection fraction; MI: motivational interviewing; MI: myocardial infarction; NA: not applicable; NR: not reported; NYHA: New York Heart Association; PCI: percutaneous coronary intervention; RCT: randomized controlled trial; SD: standard deviation; TTM: transtheoretical model.

Table 3. Characteristics of excluded studies

Study	**Reason for exclusion**
Aamot 2014	Wrong intervention
Antypas 2014	Wrong intervention
Arietaleanizbeascoa 2015	Wrong intervention
Arrigo 2008	Wrong intervention and outcomes
Barkley 2013	Wrong intervention
Berg 2015	Wrong intervention
Bikmoradi 2016	Wrong comparator - no comparable CR programme
Blumenthal 2016	Wrong intervention
Borg 2017	CR not comprehensive
Boyne 2014	CR not comprehensive
Bubnova 2014	Wrong intervention
CebrickGrossman 2010	Wrong comparator - no comparable CR programme
CebrickGrossman 2016	Wrong intervention
Chair 2012	Wrong intervention
Chokshi 2018	CR not comprehensive

Claes 2017	Outcomes of interest not measured
Cooper 2016	Wrong intervention
Daltroy 1985	CR not comprehensive (i.e. exercise only)
Dankner 2015	Wrong study design
Devi 2014	Wrong comparator - no comparable CR programme
Doletsky 2014	CR not comprehensive
Dougherty 2015	CR not comprehensive
Duncan 2003	CR not comprehensive
Duncan 2014	CR not comprehensive (i.e. exercise only)
Everson-Rose 2016	Wrong comparator - no comparable CR programme
Frederix 2013a	Wrong intervention
Frederix 2013b	Wrong intervention
Frederix 2014	Wrong intervention
Frederix 2015	Wrong intervention
Frederix 2016	Wrong intervention
Fulton 2011	CR not comprehensive
Gaalema 2016	Wrong study design

Garcia 2013	Wrong intervention
Hawkes 2013	Wrong comparator - no comparable CR programme
Hillebrand 1995	Wrong intervention - intervention delivered after CR
Irazusta-Cordoba 2017	Outcomes of interest not measured
Izawa 2005	Wrong intervention - intervention delivered after CR
Kaminsky 2013	CR not comprehensive
Kidholm 2016	Outcomes of interest not measured
Korzeniowska Kubacka 2015	Wrong study design
Korzeniowska-Kubacka 2014	Wrong study design
Lear 2014	Wrong comparator - no comparable CR programme
Lear 2015	Wrong comparator - no comparable CR programme
Lewinter 2014	Wrong intervention
Li 2015	Wrong comparator - no comparable CR programme
Mayer Berger 2016	Wrong intervention
Melin 2014	Wrong intervention
Meng 2016	Wrong intervention
Mohammadi 2018	Wrong intervention

Moholdt 2012	Wrong intervention
Moore 2006	Wrong intervention - intervention delivered after CR
Murray 2014	Wrong study design
O'Neil 2012	Wrong intervention
Oerkild 2012	Wrong comparator - no comparable CR programme
Pandey 2016	Wrong intervention
Pandey 2017	Wrong comparator - no comparable CR programme
Pattyn 2016	Wrong intervention
PeclatFlores 2015	Wrong intervention
Peixoto 2015	Wrong comparator - no comparable CR programme
PfaeffliDale 2015a	Wrong comparator - no comparable CR programme
Piotrowicz 2012	Wrong study design
Piotrowicz 2015	Wrong comparator - no comparable CR programme
Poortaghi 2013	Wrong intervention
Reyes 2013	Wrong intervention
Rodrigues 2013	Wrong intervention
Ruivo 2017	CR not comprehensive

Safiyari Hafizi 2016	Wrong intervention
Sangster 2015	Wrong intervention
Sanjuan 2016	Wrong intervention
Shahriari 2013	Wrong intervention
Skobel 2017	Wrong intervention
Sniehotta 2006	CR not comprehensive (i.e. exercise only)
Takase 2015	Wrong comparator - no comparable CR programme
terHoeve 2018	Wrong intervention
Turkstra 2013	Wrong intervention
Uysal 2015	Wrong study design
Vahedian Azimi 2016	Wrong intervention
Vanhees 2014	Wrong intervention
Widmer 2017	Wrong intervention - no specific aim to increase CR utilization
Wieczorrek 2016	CR not comprehensive
Wojcieszczyk 2012	Wrong intervention
Wolszakiewicz 2015	Wrong study design
Wood 2016	CR not comprehensive

Young 2016	Wrong intervention
Çavu o lu 2017	Wrong intervention

CR: cardiac rehabilitation.

Table 4. Characteristics of studies awaiting classification

Ivers 2017

Methods	Pragmatic, multi-centre, 3-arm RCT
Participants	Patients post MI
Interventions	Eligible patients were randomized to 1 of 3 study arms: (1) usual care (no standardised follow-up interventions); (2) usual care plus a series of mail-outs with content specifically designed to target the determinants of medication persistence and completion of CR, including information for participants to share with their personal clinicians; or (3) usual care, plus the same mail-outs, plus automated reminder telephone calls to identify participants at risk of non-adherence and a trained lay health worker (LHW) to provide additional support and navigation for such participants via telephone
Outcomes	One of 2 co-primary outcomes was assessed 12 months post MI: completion of CR. Secondary outcomes measured at 12 months included extent of CR attendance
Notes	Note that the protocol is published, and the trial has been concluded. Analyses are currently being performed

LaValley 2017

Methods	2-parallel-group RCT, single-blind
Participants	Sequential patients at risk for non-adherence to CR, based upon barriers identified at CR intake
Interventions	Participants randomized to the intervention group (n = 49) received a telephone call that centred on the participant's motivation for change, review of education received at orientation, risk factors, and goals. The control group received the standard of care (n = 61)
Outcomes	Percentage of participants in each group that attended the second exercise session Overall return rate
Notes	The manuscript presenting results has been drafted and submitted to journals for review

Rouleau 2017

Methods	2 parallel groups (1:1 concealed allocation), unblinded
Participants	Patients with acute coronary syndrome; 96 patients randomized to intervention (n = 47) and comparator groups (n = 49)

Interventions	Participants were randomized to a single 45-minute motivational interviewing session delivered after referral to, but before enrolment in, a 24-session outpatient CR programme or to usual care. The intervention was aimed at enhancing perceived benefits of CR and eliminating barriers to enrolment/attendance
Outcomes	Primary outcome was intention to attend CR Secondary outcomes included CR participation
Notes	UPBEAT manuscript with outcomes is soon to be published in *Patient Education & Counselling*

Sunamura 2018

Methods	Parallel-group trial - 3 arms
Participants	Participants with acute coronary syndrome referred for CR who attended the initial orientation session; 914 participants randomized to intervention 1 (n = 309), intervention 2 (n = 299), or comparator (n = 306)
Interventions	Participants were randomized to 3 interventions: (1) 3-month standard CR; (2) standard CR including 3 additional face-to-face active lifestyle counselling sessions and extended with 3-group fitness training and general lifestyle counselling sessions in the first 9 months after standard CR; or (3) standard CR extended for 9 months with 5 to 6 telephone general lifestyle counselling sessions
Outcomes	Primary outcome: systematic coronary risk evaluation (SCORE) for 10-year cardiovascular mortality risk at 18-month follow-up
Notes	OPTICARE authors contacted for further details, as completion of allocated treatment was reported in each arm at the beginning of the results section but was not defined

Suskin 2006

Methods	2-parallel-group, single-blind
Participants	> 18 years of age; patients post MI, unstable angina, CABG surgery, or coronary angioplasty; 60 participants
Interventions	Pre-discharge videotape introducing the concept and benefit of CR; control participants not exposed to videotape
Outcomes	Primary outcome: expressed intent to participate in a CR secondary prevention programme Secondary outcomes: number of participants who continued to adhere to the 6-month CR secondary

	prevention programme beyond the initial expressed intent to participate
Notes	Study author contacted to verify if the study was conducted and published (i.e. no results are posted despite statement that final data were collected in August 2005)

Taylor 2010a

Methods	2 parallel groups (18 intervention and 13 control)
Participants	> 18 years of age; attending first CR class at 1 of 3 hospital sites
Interventions	1-session psychological intervention, aimed at changing participants' illness beliefs via motivational interviewing; control group received treatment as usual
Outcomes	Primary outcome: CR adherence operationalized as the number of total sessions attended, ascertained 3 months post recruitment
Notes	Trial shown as complete on clinicaltrials.gov (identifier # NCT00956657), but only very basic results posted. Study author contacted for further details

CABG: coronary artery bypass graft; CR: cardiac rehabilitation; LHW: lay health worker; MI: myocardial infarction; RCT: randomized controlled trial

Table 5. Characteristics of ongoing studies

Collela 2016

Study name	MyCardiacRecovery (MyCaRe)
Methods	2-parallel-group, pilot, single-blinded RCT
Participants	> 35 years of age; undergoing CABG surgery with an uncomplicated postoperative course; standard length of hospital stay (4 to 8 days); access to wifi Internet in their home; able to hear telephone conversation; residing within the greater Toronto region (GTA) or, if outside GTA, willing to return devices via mail upon study completion
Interventions	MyCardiacRecovery (MyCaRe) is an interactive platform (app) that includes a standardised educational curriculum and interactive tracking (e.g. activity progression using photo capabilities and Fitbit flex accelerometer) for support during the first 6 to 8 weeks post hospital discharge. This application will help patients and families navigate their way through the continuum of care by providing (1) an

	integrated link between acute care and outpatient CR for efficient co-ordination of information and reduction in duplication of services; (2) participant care and educational materials designed to address salient recovery questions; (3) improved communication between the participant and care providers; and (4) ensured streamlined systematic referral to CR. Control group receives usual care (which often includes CR referral); 20 participants per arm
Outcomes	Primary outcome: enrolment in CR (6 to 8 weeks post bypass)
Starting date	1 July 2016
Contact information	Tracey Colella, University of Health Network, Toronto, Ontario, Canada.
Notes	

Gaalema 2014

Study name	Increasing CR participation among Medicaid enrollees trial
Methods	2-parallel group RCT; unblinded
Participants	Medicaid (government-supported insurance plan for low-income patients) patients > 18 years old with recent myocardial infarction, revascularization, or heart failure randomizing 130 participants
Interventions	Using financial incentives for increasing CR participation. Participants will receive financial incentives contingent on initiation of and continued attendance at CR sessions Usual care group receives no incentives
Outcomes	Attendance at CR exercise sessions; cost-effectiveness also being tested
Starting date	1 January 2017
Contact information	Diann Gaalema, The University of Vermont, Human Behavioral Pharm Lab, Burlington, Vermont, United States.
Notes	Trial may not be eligible for this review, as primary outcome is attendance at exercise sessions (not CR sessions)

Suhar 2016

Study name	Healing touch intervention in post-cardiac event patients prior to starting a cardiac rehab program trial
Methods	Parallel-group RCT
Participants	Patients referred for CR
Interventions	6 one-hour treatments over 3 weeks of healing touch therapy while participants wait to enter a CR

	programme
Outcomes	Improvement in stress and anxiety symptoms Metabolic equivalent of task Body mass index Attendance at CR sessions
Starting date	1 July 2017
Contact information	Christopher Suhar, Scripps Center for Integrative Medicine, San Diego, California, United States.
Notes	

CABG: coronary artery bypass graft; CR: cardiac rehabilitation; GTA: Greater Toronto area; RCT: randomized controlled trial.

DATA AND ANALYSES

Table 6. Comparison 1. CR utilization

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Enrolment	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
2 Enrolment - CR setting	9	1650	Risk Ratio (M-H, Random, 95% CI)	1.12 [1.04, 1.21]
2.1 supervised	6	1247	Risk Ratio (M-H, Random, 95% CI)	1.11 [1.01, 1.22]
2.2 at least some unsupervised	4	403	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.99, 1.32]
3 Enrolment - intervention target	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
3.1 patient	14	2499	Risk Ratio (M-H, Random, 95% CI)	1.22 [1.10, 1.35]
3.2 other	2	597	Risk Ratio (M-H, Random, 95% CI)	1.79 [1.40, 2.29]

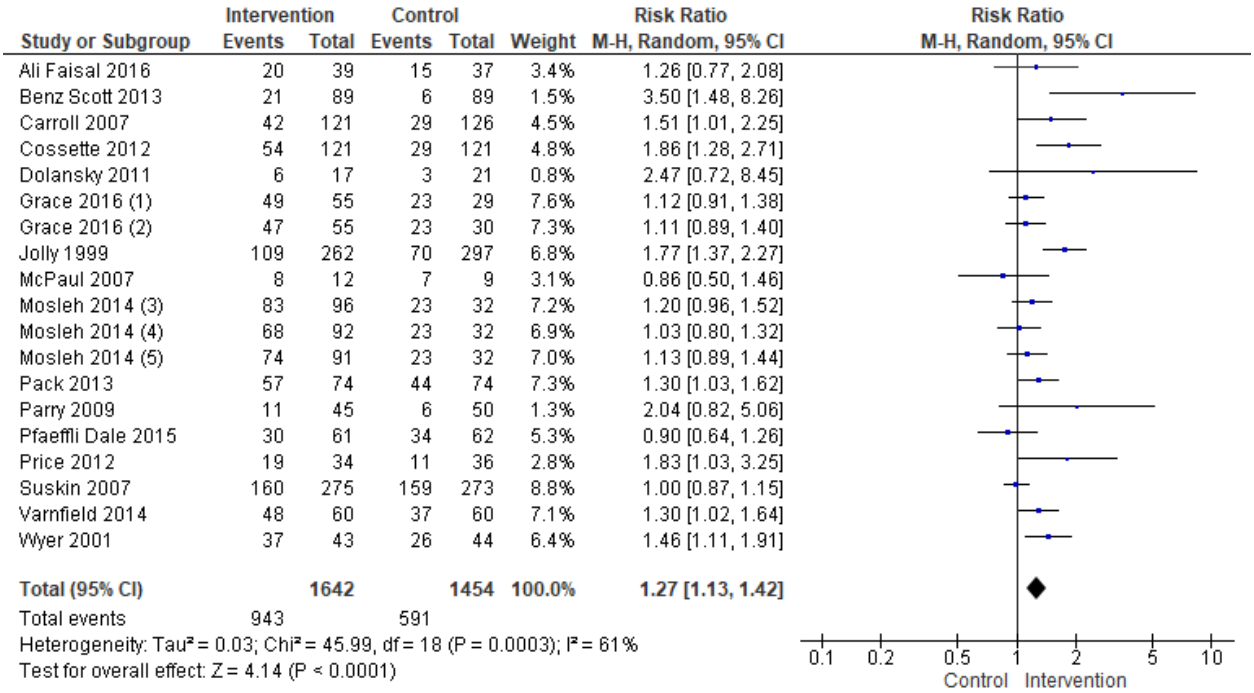
4 Enrolment - intervention contacts	13	2659	Risk Ratio (M-H, Random, 95% CI)	1.32 [1.13, 1.54]
4.1 ≥ 5 contacts	4	535	Risk Ratio (M-H, Random, 95% CI)	1.38 [0.93, 2.05]
4.2 < 5 contacts	9	2124	Risk Ratio (M-H, Random, 95% CI)	1.31 [1.09, 1.57]
5 Enrolment - deliverer	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
5.1 any healthcare provider	6	1177	Risk Ratio (M-H, Random, 95% CI)	1.60 [1.28, 2.00]
5.2 other or no one	10	1919	Risk Ratio (M-H, Random, 95% CI)	1.17 [1.06, 1.29]
6 Enrolment - delivery format	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
6.1 any face-to-face	7	1361	Risk Ratio (M-H, Random, 95% CI)	1.59 [1.24, 2.05]
6.2 no face-to-face	9	1735	Risk Ratio (M-H, Random, 95% CI)	1.16 [1.06, 1.26]
7 Enrolment - theory-based	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
7.1 yes	7	1182	Risk Ratio (M-H, Random, 95% CI)	1.28 [1.09, 1.51]
7.2 no	9	1914	Risk Ratio (M-H, Random, 95% CI)	1.26 [1.07, 1.49]
8 Enrolment - outcome ascertainment	11	1835	Risk Ratio (M-H, Random, 95% CI)	1.42 [1.20, 1.68]
8.1 self-report	3	876	Risk Ratio (M-H, Random, 95% CI)	1.71 [1.40, 2.08]
8.2 chart report	8	959	Risk Ratio (M-H, Random, 95% CI)	1.33 [1.10, 1.61]
9 Enrolment - number of sites	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
9.1 multi-site	9	1786	Risk Ratio (M-H, Random, 95% CI)	1.22 [1.05, 1.43]
9.2 single-centre	7	1310	Risk Ratio (M-H, Random, 95% CI)	1.37 [1.13, 1.65]
10 Enrolment - cardiac indication	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
10.1 some patients with HF included	6	839	Risk Ratio (M-H, Random, 95% CI)	1.42 [1.18, 1.71]

10.2 no patients with HF included	10	2257	Risk Ratio (M-H, Random, 95% CI)	1.21 [1.06, 1.38]
11 Enrolment - region	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
11.1 North America	10	1811	Risk Ratio (M-H, Random, 95% CI)	1.35 [1.14, 1.61]
11.2 other	6	1285	Risk Ratio (M-H, Random, 95% CI)	1.21 [1.03, 1.42]
12 Enrolment - peer navigation	16	3096	Risk Ratio (M-H, Random, 95% CI)	1.27 [1.13, 1.42]
12.1 yes	4	596	Risk Ratio (M-H, Random, 95% CI)	1.69 [1.16, 2.45]
12.2 no	12	2500	Risk Ratio (M-H, Random, 95% CI)	1.23 [1.10, 1.37]
13 Enrolment - sensitivity analysis - low risk of bias studies	11	2155	Risk Ratio (M-H, Random, 95% CI)	1.29 [1.13, 1.48]
14 Enrolment - sensitivity analysis - without cluster RCT (Jolly)	15	2537	Risk Ratio (M-H, Random, 95% CI)	1.23 [1.11, 1.36]
15 Adherence	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
16 Adherence - deliverer	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
16.1 any healthcare provider	2	1077	Std. Mean Difference (IV, Random, 95% CI)	0.25 [0.05, 0.45]
16.2 other or no one	6	577	Std. Mean Difference (IV, Random, 95% CI)	0.44 [0.22, 0.66]
17 Adherence - delivery format	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
17.1 any face-to-face	5	1384	Std. Mean Difference (IV, Random, 95% CI)	0.37 [0.16, 0.59]
17.2 no face-to-face	3	270	Std. Mean Difference (IV, Random, 95% CI)	0.40 [0.05, 0.75]
18 Adherence - number of sites	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
18.2 single-centre	3	421	Std. Mean Difference (IV, Random, 95% CI)	0.46 [0.26, 0.65]
18.1 multi-site	5	1233	Std. Mean Difference (IV, Random, 95% CI)	0.33 [0.08, 0.57]

19 Adherence - cardiac indication	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
19.1 some patients with HF included	3	1023	Std. Mean Difference (IV, Random, 95% CI)	0.52 [0.07, 0.97]
19.2 no patients with HF included	5	631	Std. Mean Difference (IV, Random, 95% CI)	0.35 [0.19, 0.51]
20 Adherence - CR setting	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
20.1 supervised	4	1203	Std. Mean Difference (IV, Random, 95% CI)	0.20 [0.09, 0.32]
20.2 at least some unsupervised	5	451	Std. Mean Difference (IV, Random, 95% CI)	0.56 [0.37, 0.76]
21 Adherence - region	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
21.1 North America	5	728	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.56]
21.2 other	3	926	Std. Mean Difference (IV, Random, 95% CI)	0.48 [0.01, 0.95]
22 Adherence - theory	8	1654	Std. Mean Difference (IV, Random, 95% CI)	0.38 [0.20, 0.55]
22.1 yes	6	1434	Std. Mean Difference (IV, Random, 95% CI)	0.39 [0.19, 0.59]
22.2 no	2	220	Std. Mean Difference (IV, Random, 95% CI)	0.36 [-0.10, 0.82]
23 Adherence - sensitivity analysis - low risk of bias studies	7	1613	Std. Mean Difference (IV, Random, 95% CI)	0.40 [0.21, 0.58]
24 Completion	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
25 Completion - CR setting	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
25.1 supervised	5	1219	Risk Ratio (M-H, Random, 95% CI)	1.09 [1.02, 1.17]
25.2 at least some unsupervised	3	346	Risk Ratio (M-H, Random, 95% CI)	1.24 [0.75, 2.07]
26 Completion - delivery format	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
26.1 any face-to-face	4	1128	Risk Ratio (M-H, Random, 95% CI)	1.07 [1.02, 1.13]

26.2 no face-to-face	3	437	Risk Ratio (M-H, Random, 95% CI)	1.34 [1.03, 1.75]
27 Completion - theory-based	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
27.1 yes	4	1128	Risk Ratio (M-H, Random, 95% CI)	1.07 [1.02, 1.13]
27.2 no	3	437	Risk Ratio (M-H, Random, 95% CI)	1.34 [1.03, 1.75]
28 Completion - number of sites	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
28.1 multi-site	4	1177	Risk Ratio (M-H, Random, 95% CI)	1.07 [1.01, 1.13]
28.2 single-centre	3	388	Risk Ratio (M-H, Random, 95% CI)	1.46 [1.17, 1.82]
29 Completion – cardiac indication	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
29.1 some patients with HF included	4	1235	Risk Ratio (M-H, Random, 95% CI)	1.16 [1.00, 1.34]
29.2 no patients with HF included	3	330	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.89, 1.34]
30 Completion - region	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
30.1 North America	5	620	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.97, 1.14]
30.2 other	2	945	Risk Ratio (M-H, Random, 95% CI)	1.34 [0.85, 2.10]
31 Completion - CR programme duration	7	1565	Risk Ratio (M-H, Random, 95% CI)	1.13 [1.02, 1.25]
31.1 <12 weeks	3	986	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.92, 1.60]
31.2 ≥12 weeks	4	579	Risk Ratio (M-H, Random, 95% CI)	1.06 [0.97, 1.14]
32 Completion - sensitivity analysis - low risk of bias studies	5	1404	Risk Ratio (M-H, Random, 95% CI)	1.14 [1.01, 1.29]

Figure 6**.** Comparison 1 CR utilization, Outcome 1 Enrolment



Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Ali Faisal 2016	20	39	15	37	3.4%	1.26 [0.77, 2.08]
Benz Scott 2013	21	89	6	89	1.5%	3.50 [1.48, 8.26]
Carroll 2007	42	121	29	126	4.5%	1.51 [1.01, 2.25]
Cossette 2012	54	121	29	121	4.8%	1.86 [1.28, 2.71]
Dolansky 2011	6	17	3	21	0.8%	2.47 [0.72, 8.45]
Grace 2016 (1)	49	55	23	29	7.6%	1.12 [0.91, 1.38]
Grace 2016 (2)	47	55	23	30	7.3%	1.11 [0.89, 1.40]
Jolly 1999	109	262	70	297	6.8%	1.77 [1.37, 2.27]
McPaul 2007	8	12	7	9	3.1%	0.86 [0.50, 1.46]
Mosleh 2014 (3)	83	96	23	32	7.2%	1.20 [0.96, 1.52]
Mosleh 2014 (4)	68	92	23	32	6.9%	1.03 [0.80, 1.32]
Mosleh 2014 (5)	74	91	23	32	7.0%	1.13 [0.89, 1.44]
Pack 2013	57	74	44	74	7.3%	1.30 [1.03, 1.62]
Parry 2009	11	45	6	50	1.3%	2.04 [0.82, 5.06]
Pfaeffli Dale 2015	30	61	34	62	5.3%	0.90 [0.64, 1.26]
Price 2012	19	34	11	36	2.8%	1.83 [1.03, 3.25]
Suskin 2007	160	275	159	273	8.8%	1.00 [0.87, 1.15]
Varnfield 2014	48	60	37	60	7.1%	1.30 [1.02, 1.64]
Wyer 2001	37	43	26	44	6.4%	1.46 [1.11, 1.91]
Total (95% CI)		**1642**		**1454**	**100.0%**	**1.27 [1.13, 1.42]**
Total events	943		591			

Heterogeneity: Tau² = 0.03; Chi² = 45.99, df = 18 (P = 0.0003); I² = 61%

Test for overall effect: Z = 4.14 (P < 0.0001)

Footnotes

(1) home-based cardiac rehab

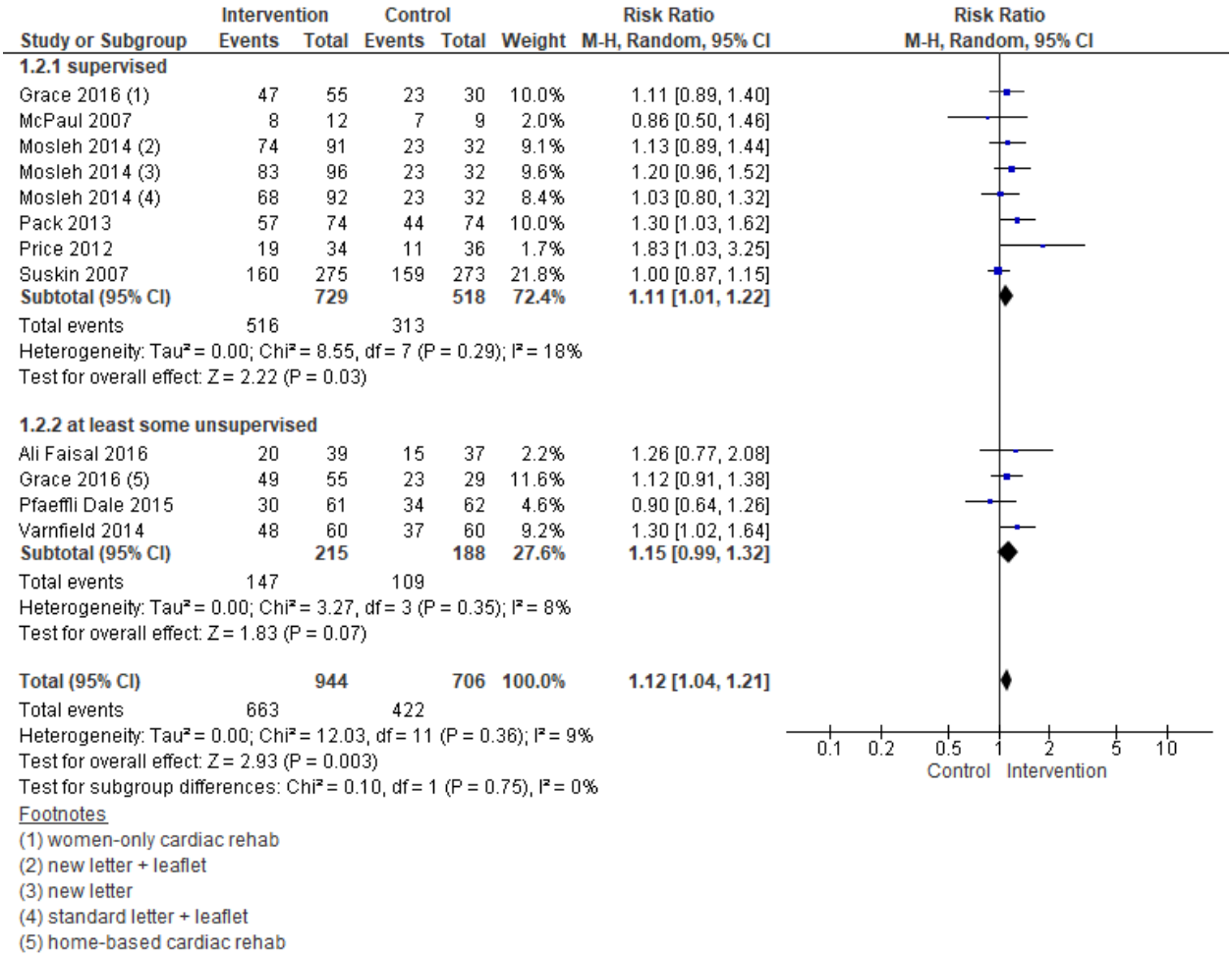
(2) women-only cardiac rehab

(3) theoretically-based cardiac rehab invitation letter

(4) standard invitation letter + motivational leaflet

(5) theoretically-based cardiac rehab invitation letter + motivational leaflet

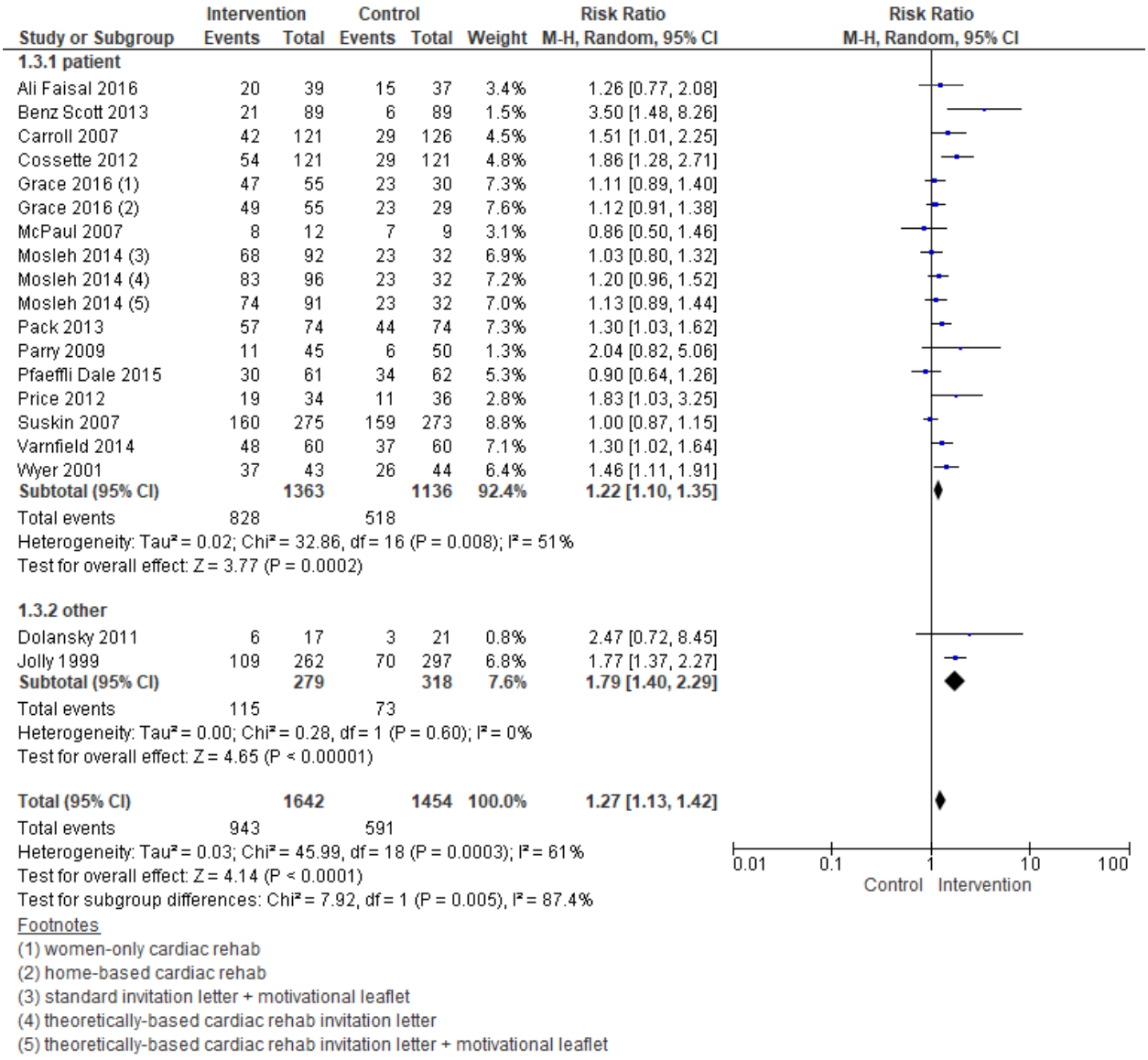
Figure 7**.** Comparison 1 CR utilization, Outcome 2 Enrolment - CR setting



Footnotes

(1) women-only cardiac rehab
(2) new letter + leaflet
(3) new letter
(4) standard letter + leaflet
(5) home-based cardiac rehab

Figure 8**.** Comparison 1 CR utilization, Outcome 3 Enrolment - intervention target



Footnotes

(1) women-only cardiac rehab

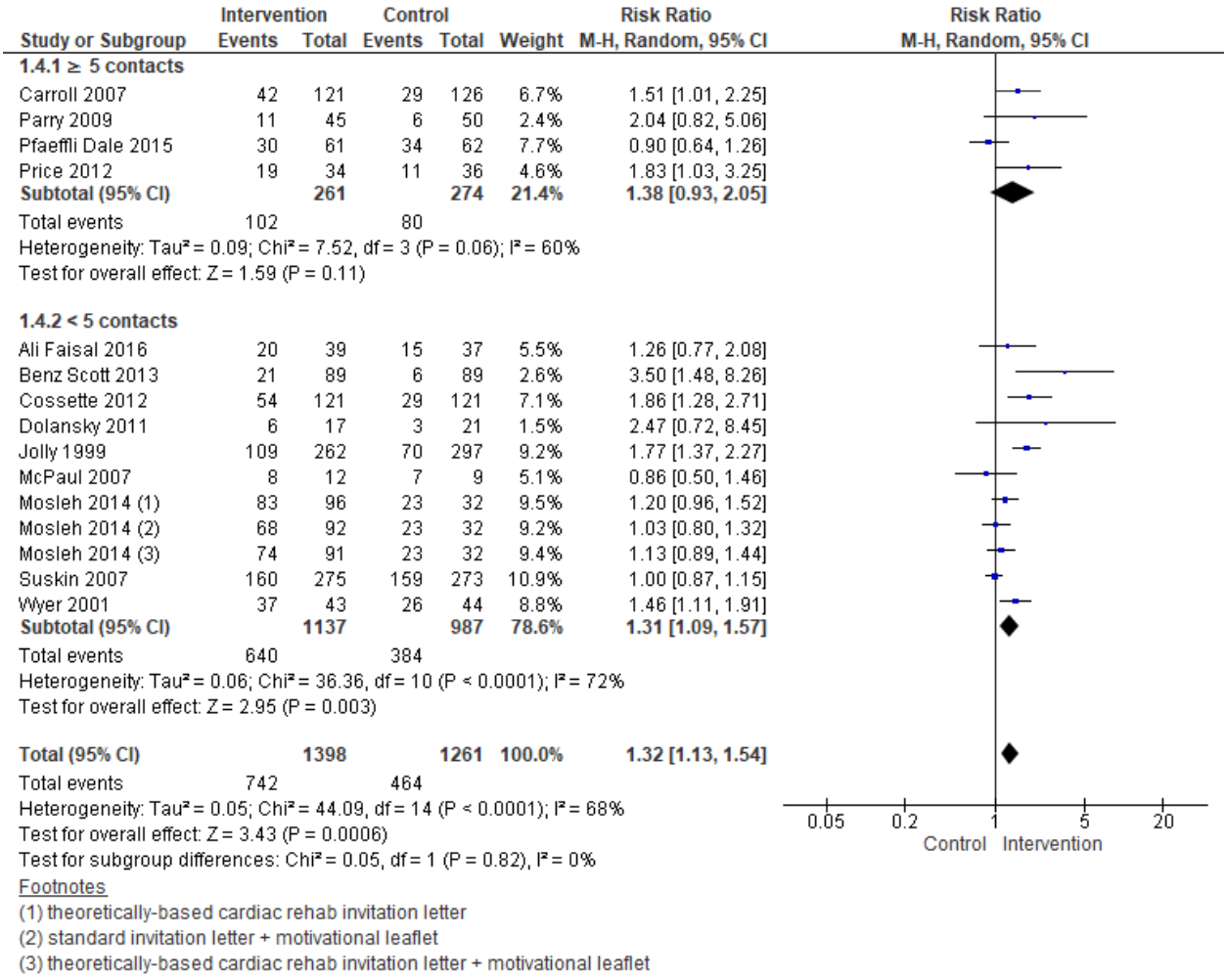
(2) home-based cardiac rehab

(3) standard invitation letter + motivational leaflet

(4) theoretically-based cardiac rehab invitation letter

(5) theoretically-based cardiac rehab invitation letter + motivational leaflet

Figure 9**.** Comparison 1 CR utilization, Outcome 4 Enrolment - intervention contacts



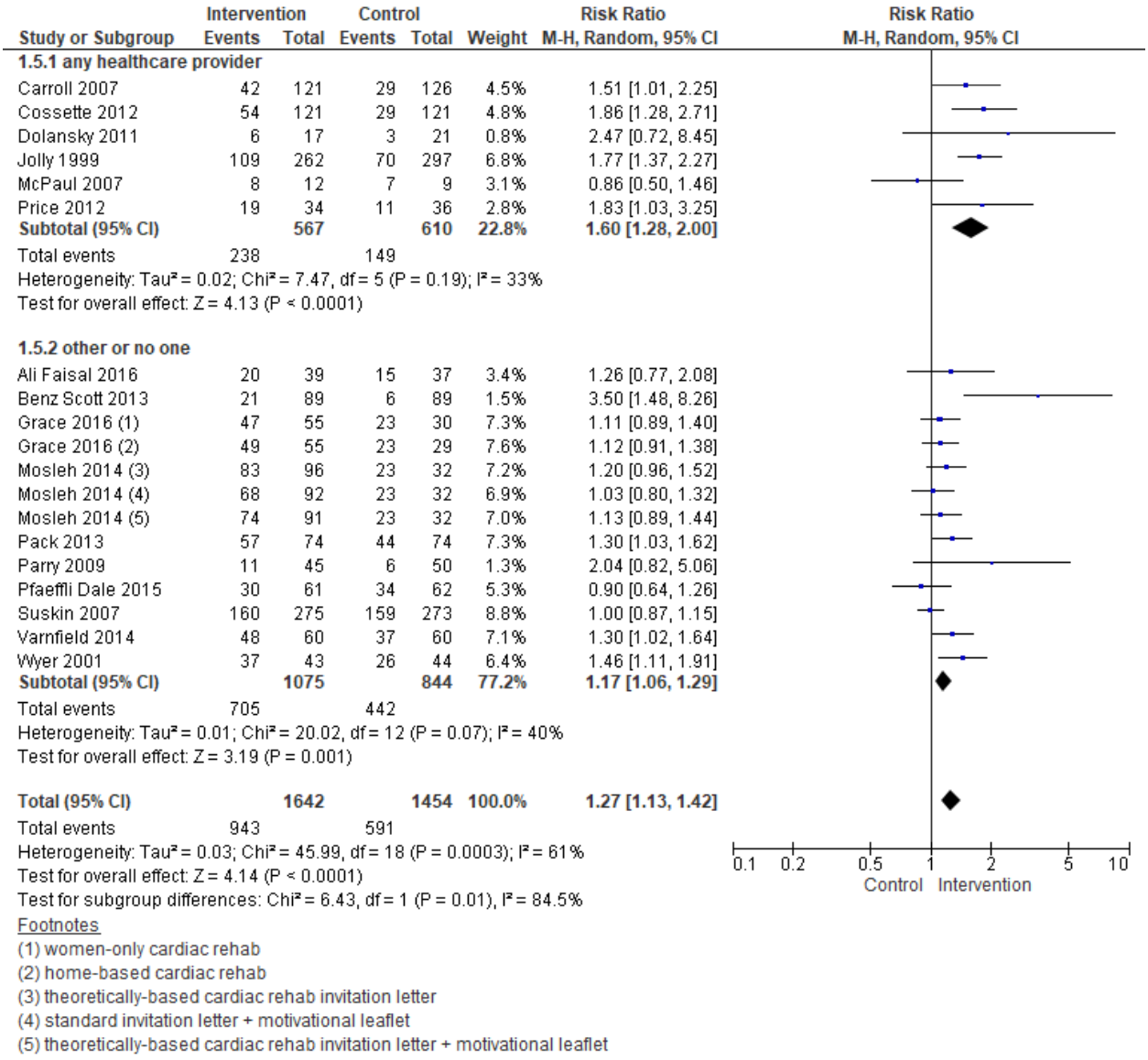
Footnotes

(1) theoretically-based cardiac rehab invitation letter

(2) standard invitation letter + motivational leaflet

(3) theoretically-based cardiac rehab invitation letter + motivational leaflet

Figure 10**.** Comparison 1 CR utilization, Outcome 5 Enrolment - deliverer



Footnotes

(1) women-only cardiac rehab

(2) home-based cardiac rehab

(3) theoretically-based cardiac rehab invitation letter

(4) standard invitation letter + motivational leaflet

(5) theoretically-based cardiac rehab invitation letter + motivational leaflet

Figure 11**.** Comparison 1 CR utilization, Outcome 6 Enrolment - delivery format

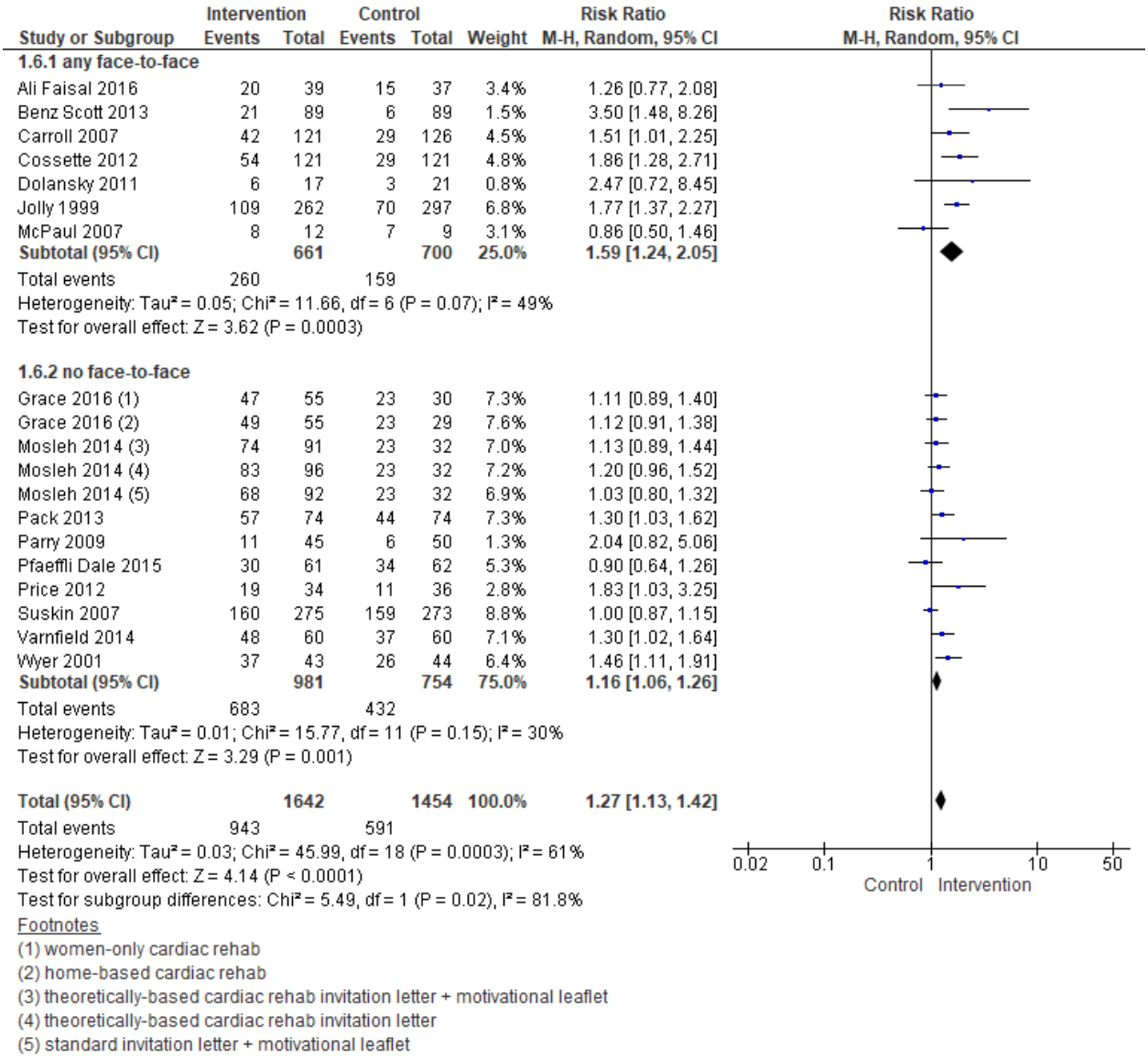
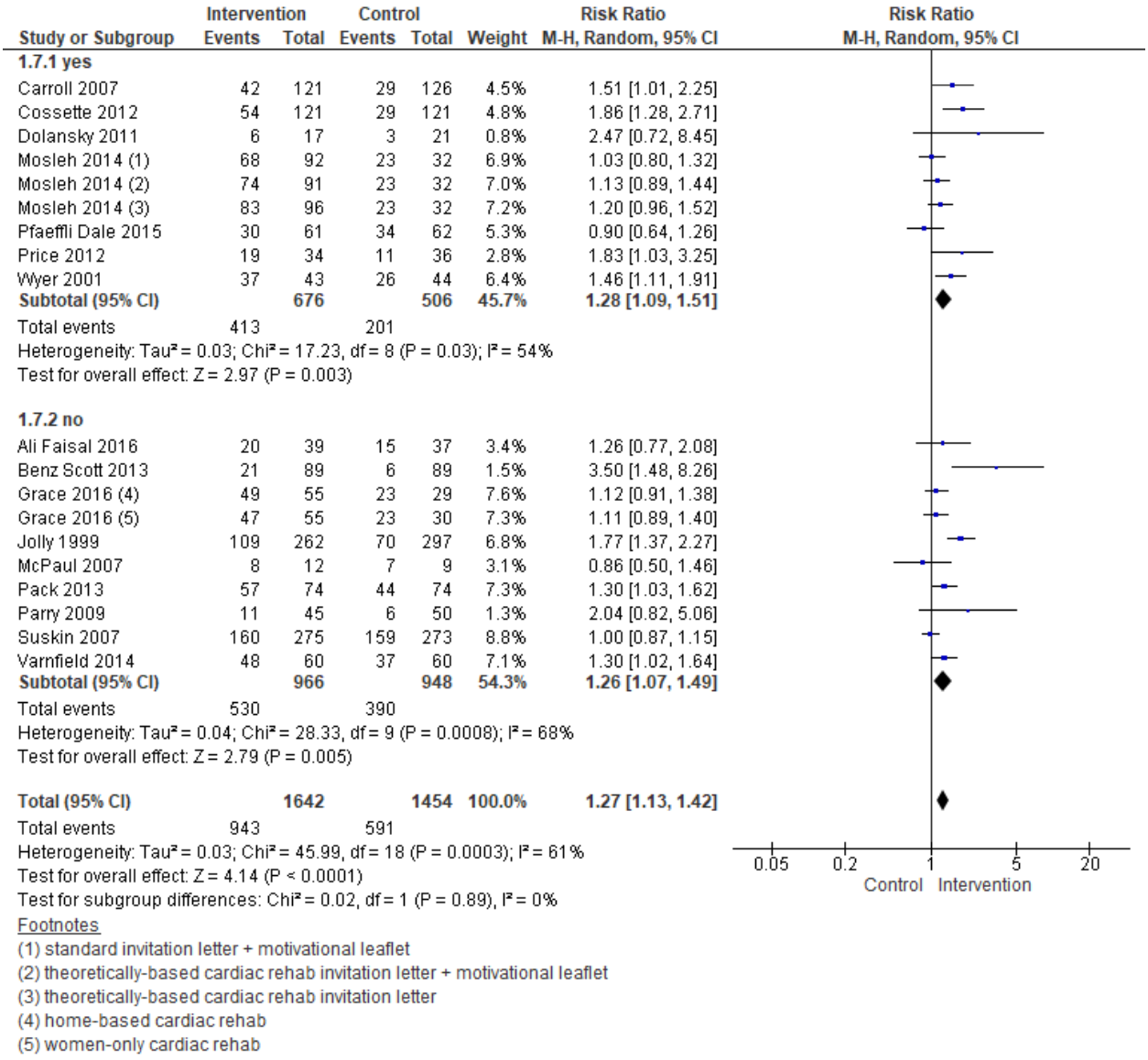


Figure 12**.** Comparison 1 CR utilization, Outcome 7 Enrolment - theory-based



Footnotes

(1) standard invitation letter + motivational leaflet

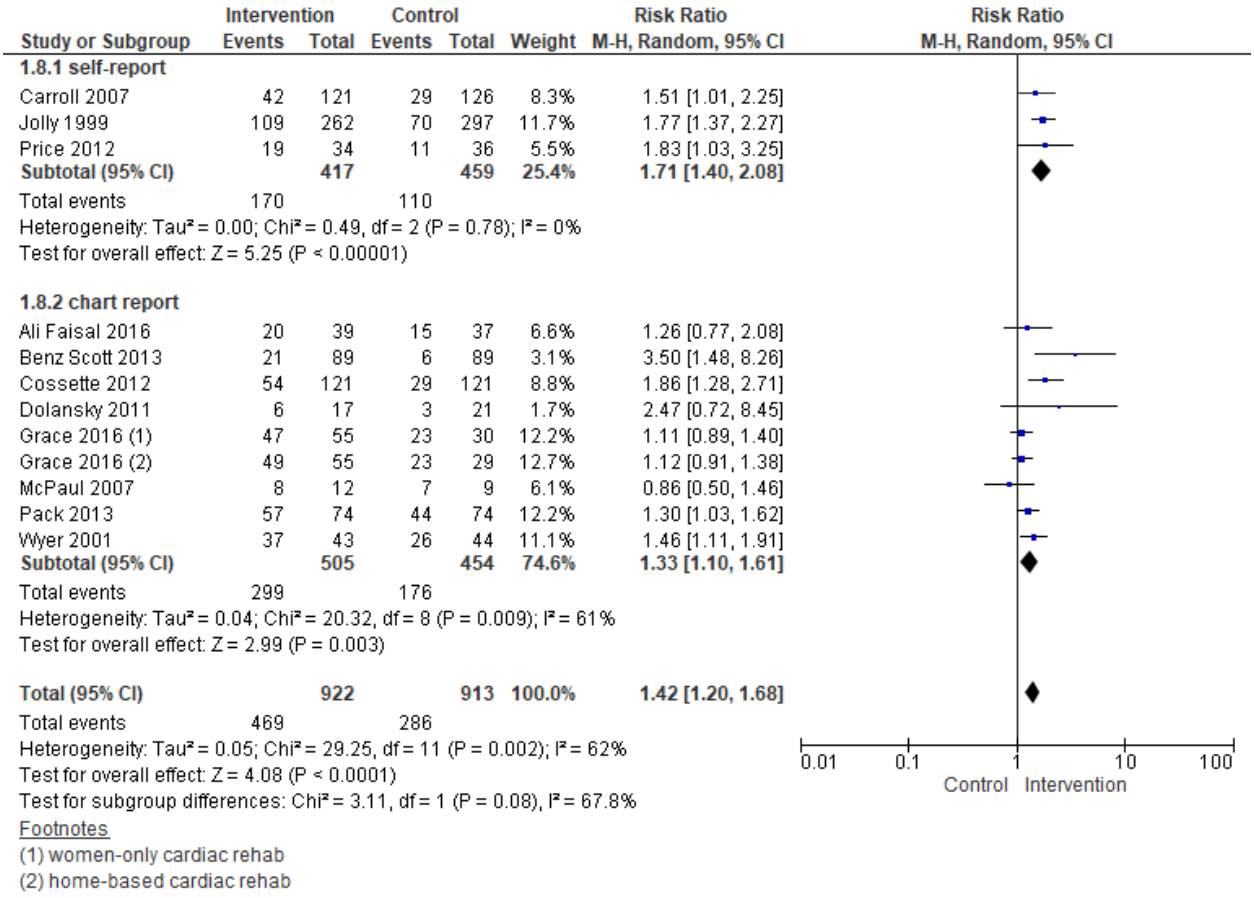
(2) theoretically-based cardiac rehab invitation letter + motivational leaflet

(3) theoretically-based cardiac rehab invitation letter

(4) home-based cardiac rehab

(5) women-only cardiac rehab

Figure 13**.** Comparison 1 CR utilization, Outcome 8 Enrolment - outcome ascertainment

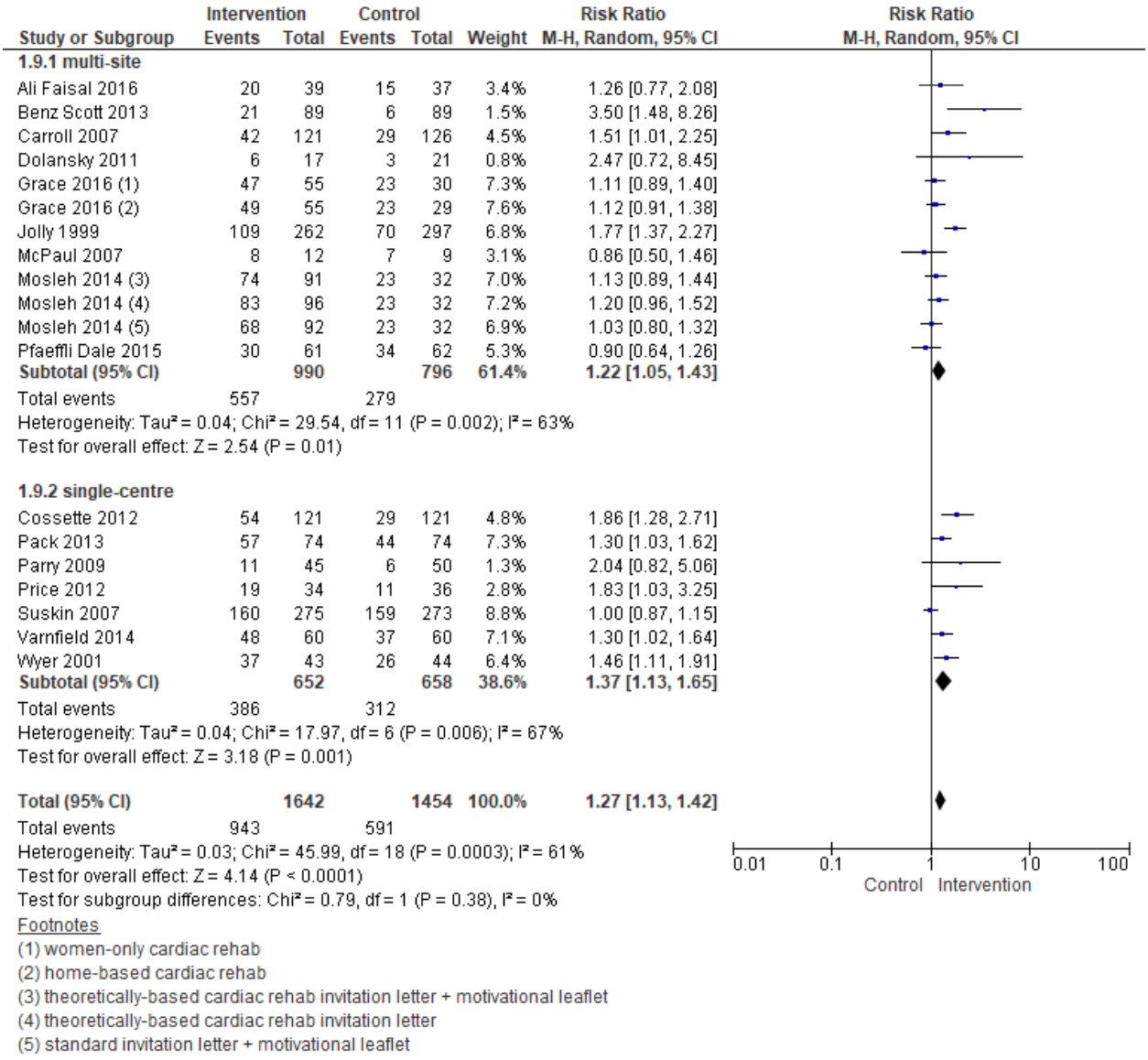


Footnotes

(1) women-only cardiac rehab

(2) home-based cardiac rehab

Figure 14**.** Comparison 1 CR utilization, Outcome 9 Enrolment - number of sites



Footnotes

(1) women-only cardiac rehab

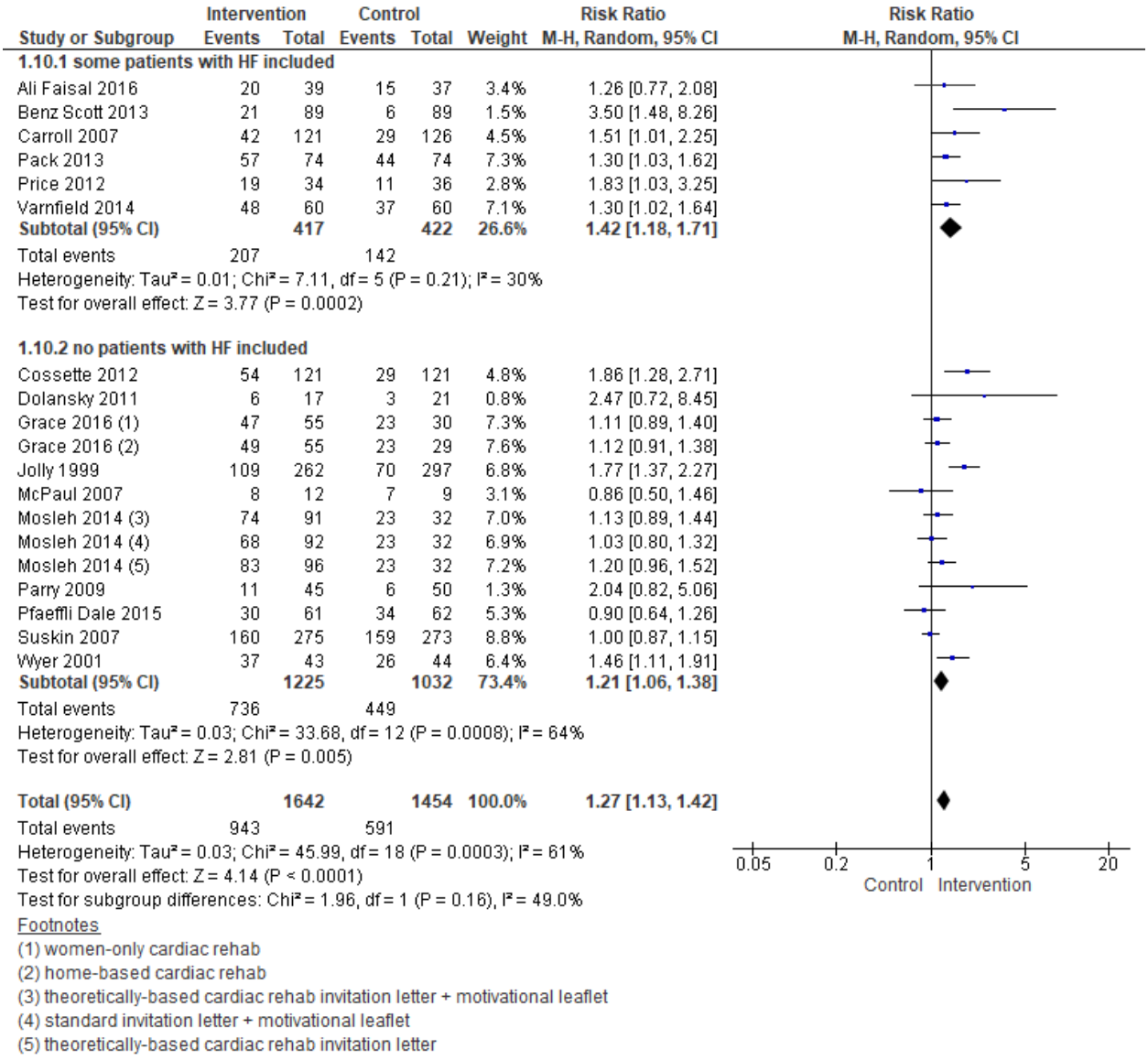
(2) home-based cardiac rehab

(3) theoretically-based cardiac rehab invitation letter + motivational leaflet

(4) theoretically-based cardiac rehab invitation letter

(5) standard invitation letter + motivational leaflet

Figure 15**.** Comparison 1 CR utilization, Outcome 10 Enrolment - cardiac indication



Footnotes

(1) women-only cardiac rehab

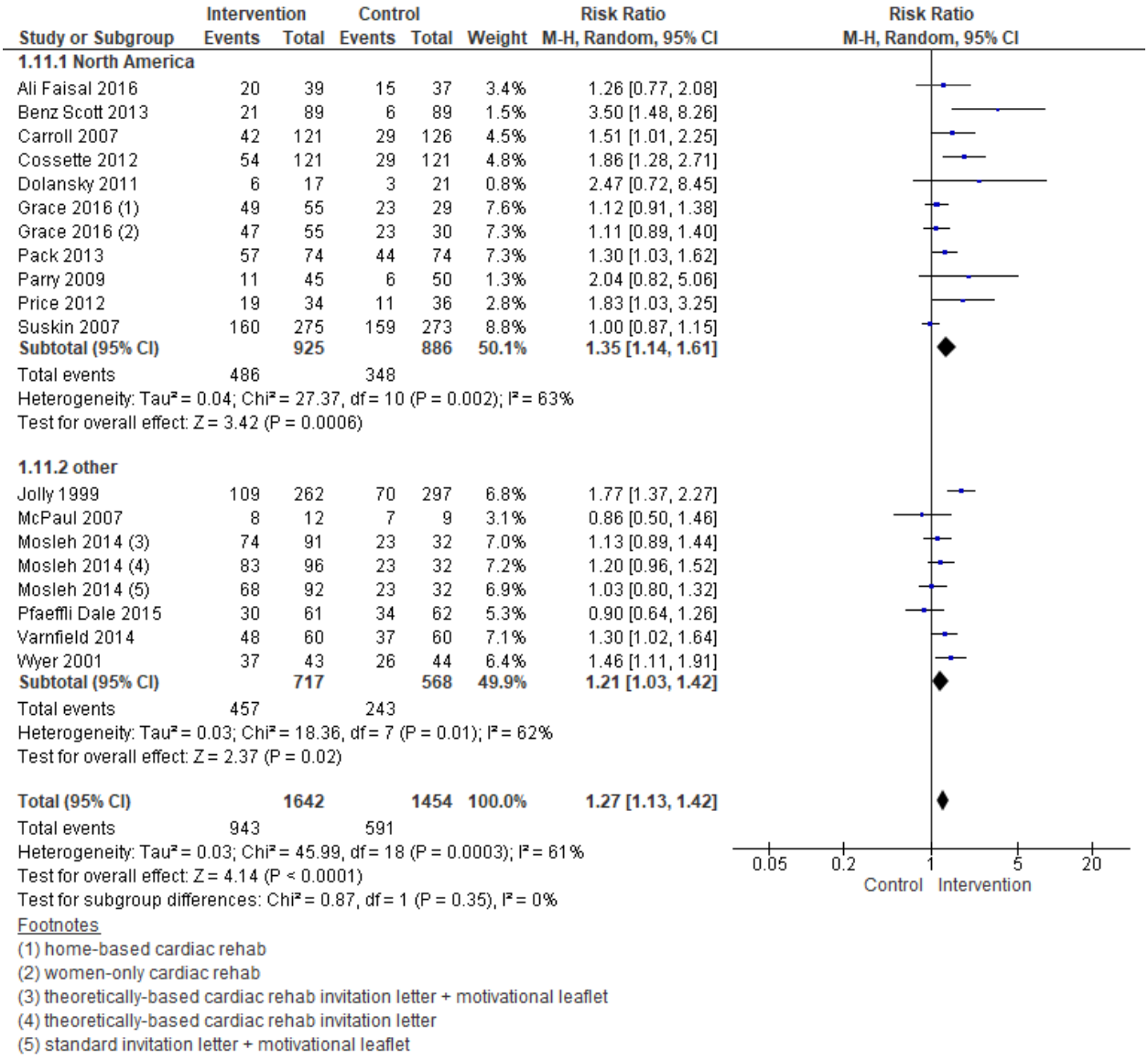
(2) home-based cardiac rehab

(3) theoretically-based cardiac rehab invitation letter + motivational leaflet

(4) standard invitation letter + motivational leaflet

(5) theoretically-based cardiac rehab invitation letter

Figure 16**.** Comparison 1 CR utilization, Outcome 11 Enrolment - region



Footnotes

(1) home-based cardiac rehab

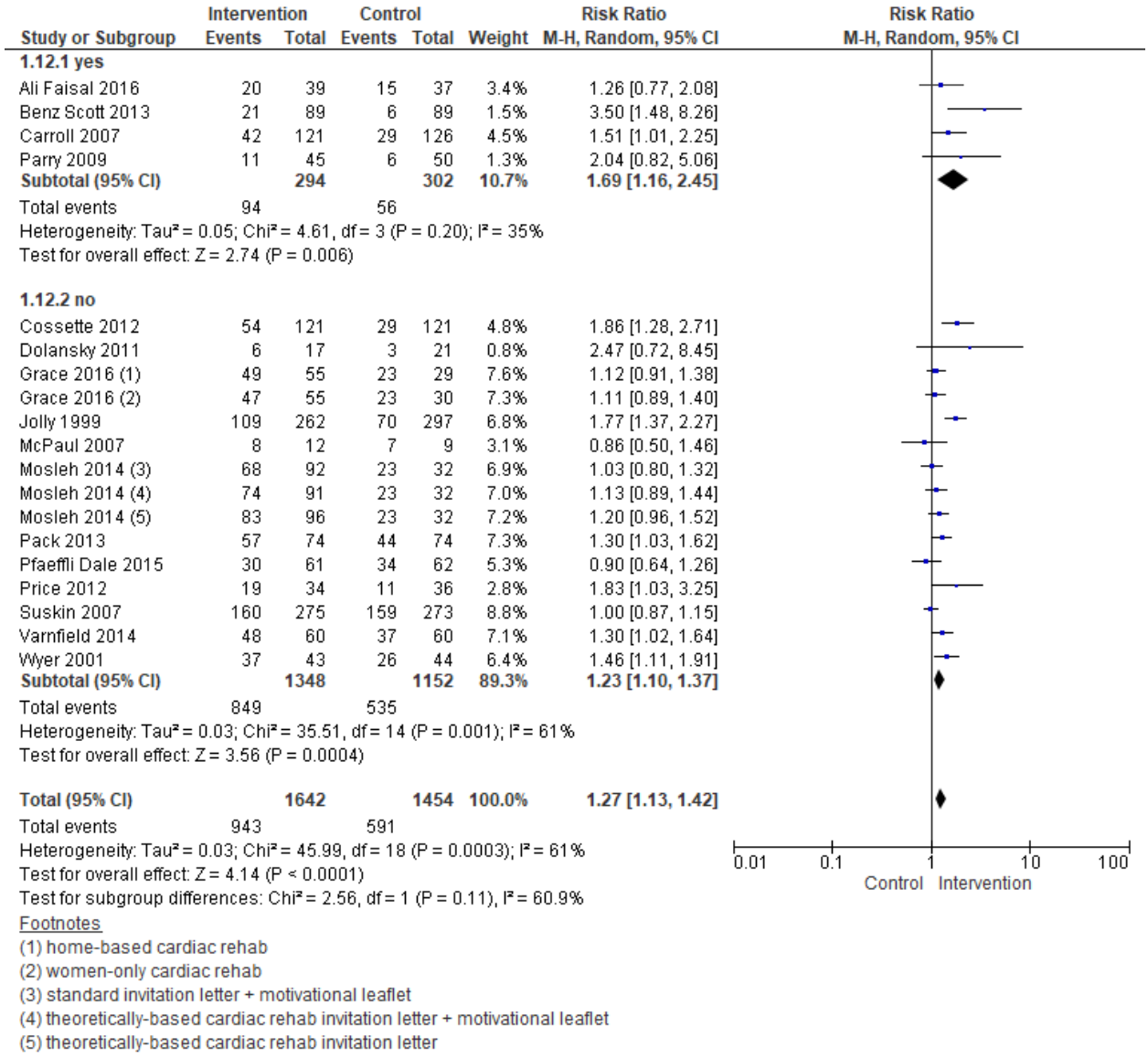
(2) women-only cardiac rehab

(3) theoretically-based cardiac rehab invitation letter + motivational leaflet

(4) theoretically-based cardiac rehab invitation letter

(5) standard invitation letter + motivational leaflet

Figure 17**.** Comparison 1 CR utilization, Outcome 12 Enrolment - peer navigation



Footnotes

(1) home-based cardiac rehab

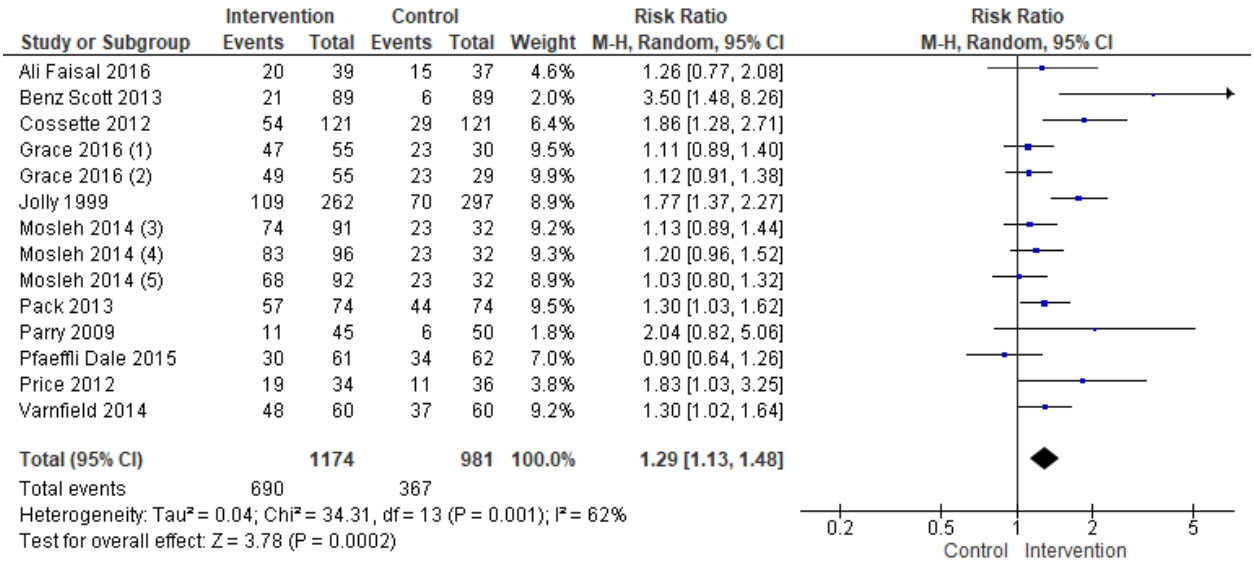
(2) women-only cardiac rehab

(3) standard invitation letter + motivational leaflet

(4) theoretically-based cardiac rehab invitation letter + motivational leaflet

(5) theoretically-based cardiac rehab invitation letter

Figure 18**.** Comparison 1 CR utilization, Outcome 13 Enrolment - sensitivity analysis - low risk of bias studies



Footnotes

(1) women-only cardiac rehab

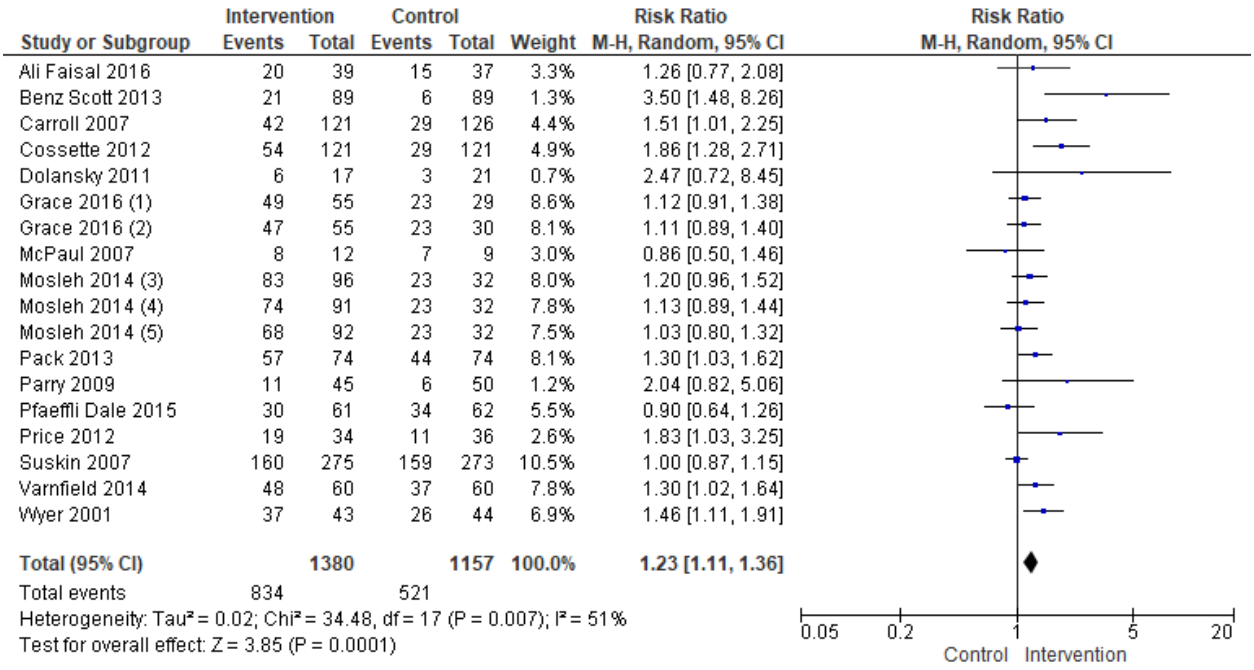
(2) home-based cardiac rehab

(3) theoretically-based cardiac rehab invitation letter + motivational leaflet

(4) theoretically-based cardiac rehab invitation letter

(5) standard invitation letter + motivational leaflet

Figure 19**.** Comparison 1 CR utilization, Outcome 14 Enrolment - sensitivity analysis - without cluster RCT (Jolly)

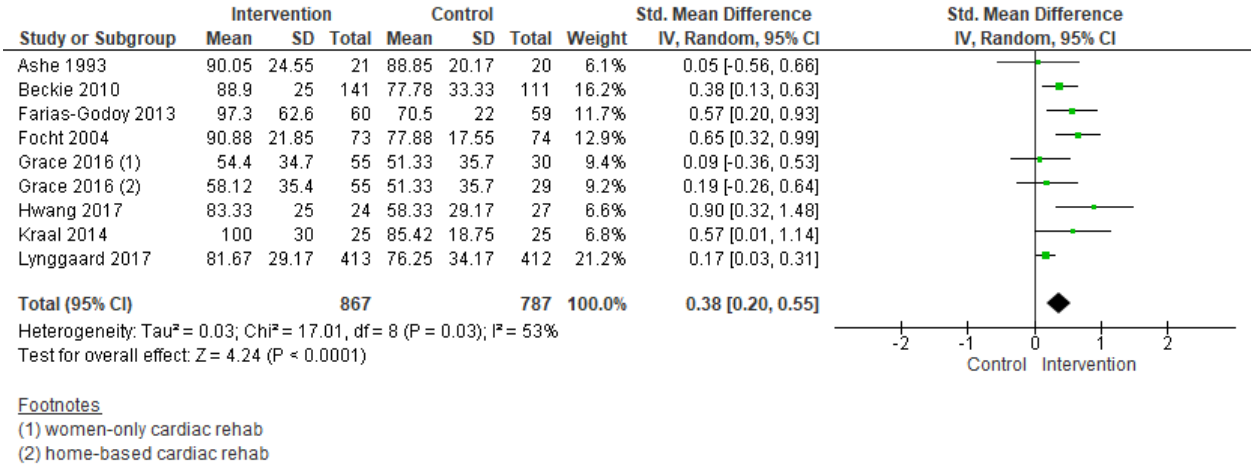


Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Ali Faisal 2016	20	39	15	37	3.3%	1.26 [0.77, 2.08]
Benz Scott 2013	21	89	6	89	1.3%	3.50 [1.48, 8.26]
Carroll 2007	42	121	29	126	4.4%	1.51 [1.01, 2.25]
Cossette 2012	54	121	29	121	4.9%	1.86 [1.28, 2.71]
Dolansky 2011	6	17	3	21	0.7%	2.47 [0.72, 8.45]
Grace 2016 (1)	49	55	23	29	8.6%	1.12 [0.91, 1.38]
Grace 2016 (2)	47	55	23	30	8.1%	1.11 [0.89, 1.40]
McPaul 2007	8	12	7	9	3.0%	0.86 [0.50, 1.46]
Mosleh 2014 (3)	83	96	23	32	8.0%	1.20 [0.96, 1.52]
Mosleh 2014 (4)	74	91	23	32	7.8%	1.13 [0.89, 1.44]
Mosleh 2014 (5)	68	92	23	32	7.5%	1.03 [0.80, 1.32]
Pack 2013	57	74	44	74	8.1%	1.30 [1.03, 1.62]
Parry 2009	11	45	6	50	1.2%	2.04 [0.82, 5.06]
Pfaeffli Dale 2015	30	61	34	62	5.5%	0.90 [0.64, 1.26]
Price 2012	19	34	11	36	2.6%	1.83 [1.03, 3.25]
Suskin 2007	160	275	159	273	10.5%	1.00 [0.87, 1.15]
Varnfield 2014	48	60	37	60	7.8%	1.30 [1.02, 1.64]
Wyer 2001	37	43	26	44	6.9%	1.46 [1.11, 1.91]
Total (95% CI)		**1380**		**1157**	**100.0%**	**1.23 [1.11, 1.36]**
Total events	834		521			

Heterogeneity: Tau² = 0.02; Chi² = 34.48, df = 17 (P = 0.007); I² = 51%
Test for overall effect: Z = 3.85 (P = 0.0001)

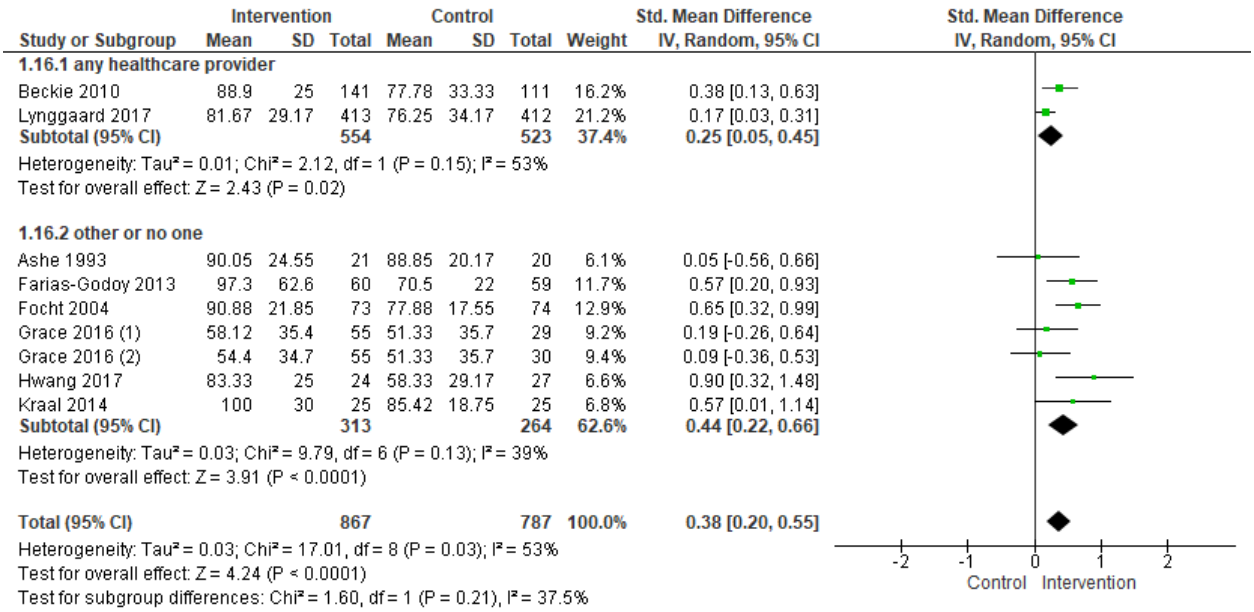
Footnotes
(1) home-based cardiac rehab
(2) women-only cardiac rehab
(3) theoretically-based cardiac rehab invitation letter
(4) theoretically-based cardiac rehab invitation letter + motivational leaflet
(5) standard invitation letter + motivational leaflet

Figure 20**.** Comparison 1 CR utilization, Outcome 15 Adherence



Footnotes
(1) women-only cardiac rehab
(2) home-based cardiac rehab

Figure 21**.** Comparison 1 CR utilization, Outcome 16 Adherence - deliverer



Footnotes
(1) home-based cardiac rehab
(2) women-only cardiac rehab

Figure 22**.** Comparison 1 CR utilization, Outcome 17 Adherence - delivery format

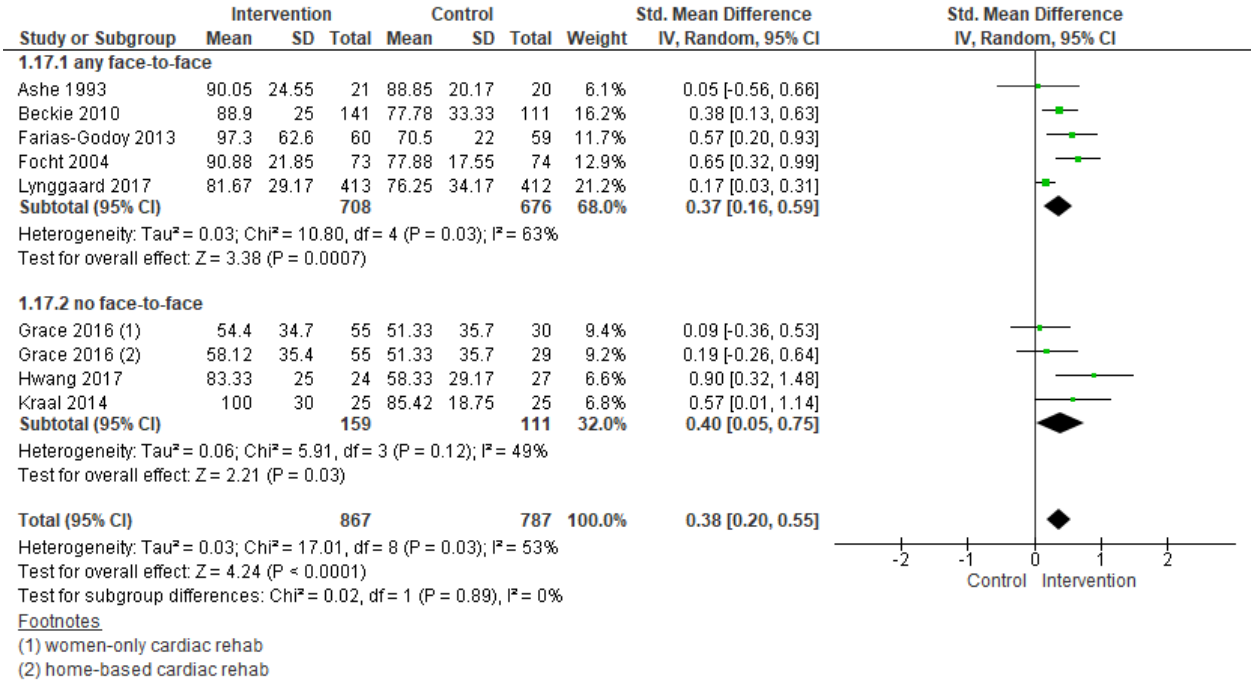


Figure 23**.** Comparison 1 CR utilization, Outcome 18 Adherence - number of sites

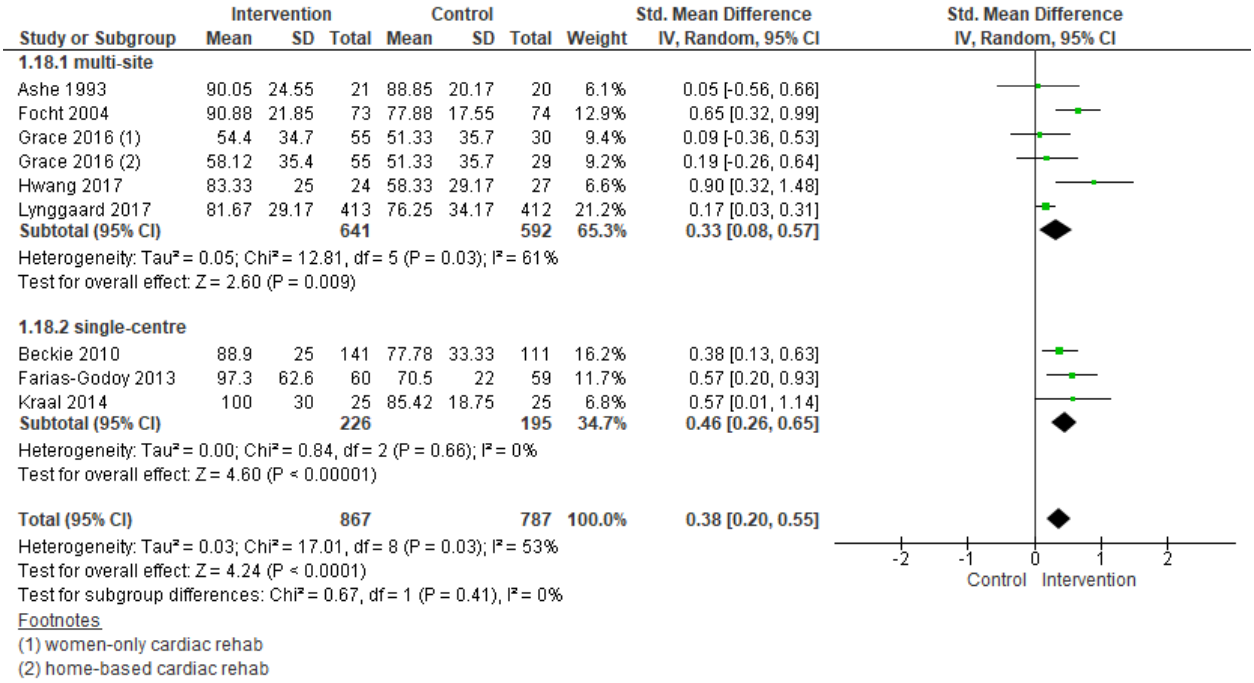


Figure 24**.** Comparison 1 CR utilization, Outcome 19 Adherence - cardiac indication

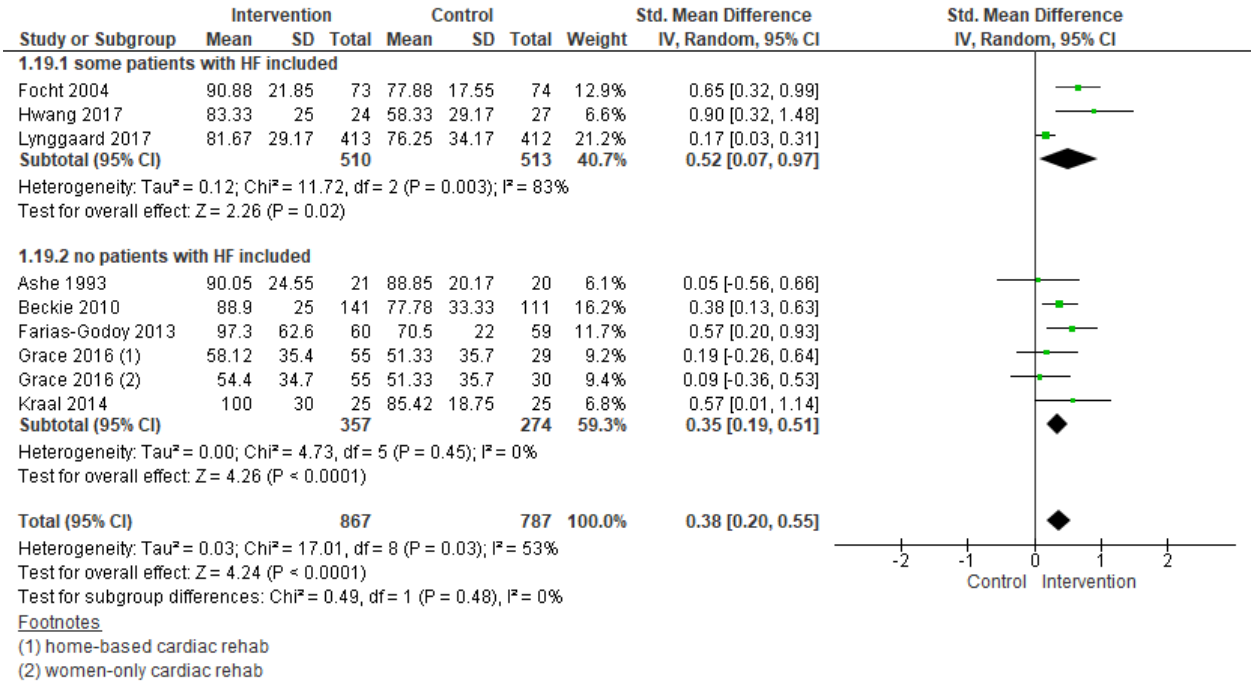


Figure 25**.** Comparison 1 CR utilization, Outcome 20 Adherence - CR setting

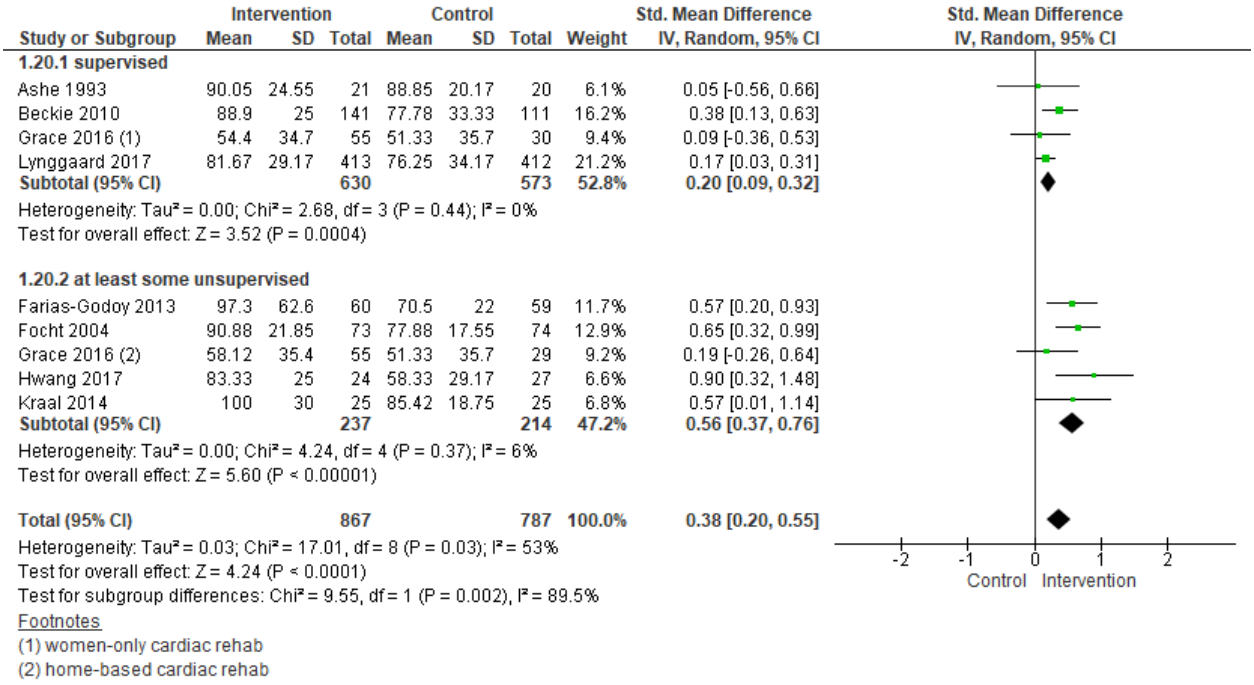


Figure 26**.** Comparison 1 CR utilization, Outcome 21 Adherence - region

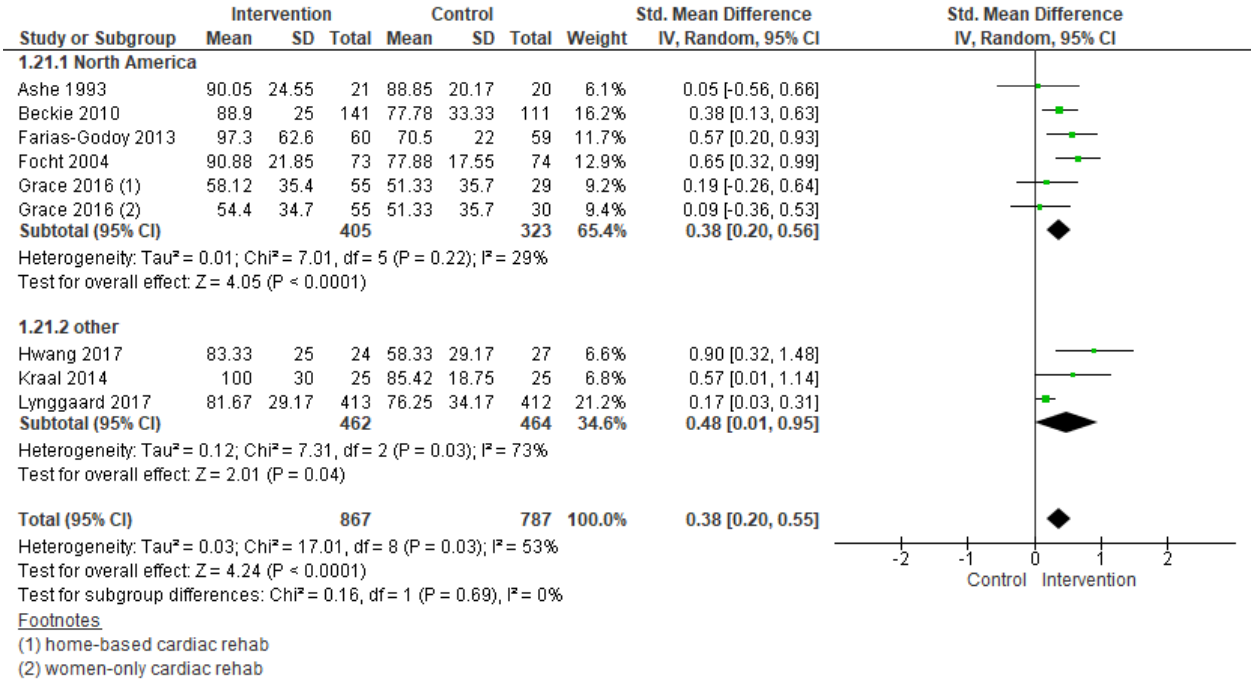


Figure 27**.** Comparison 1 CR utilization, Outcome 22 Adherence - theory

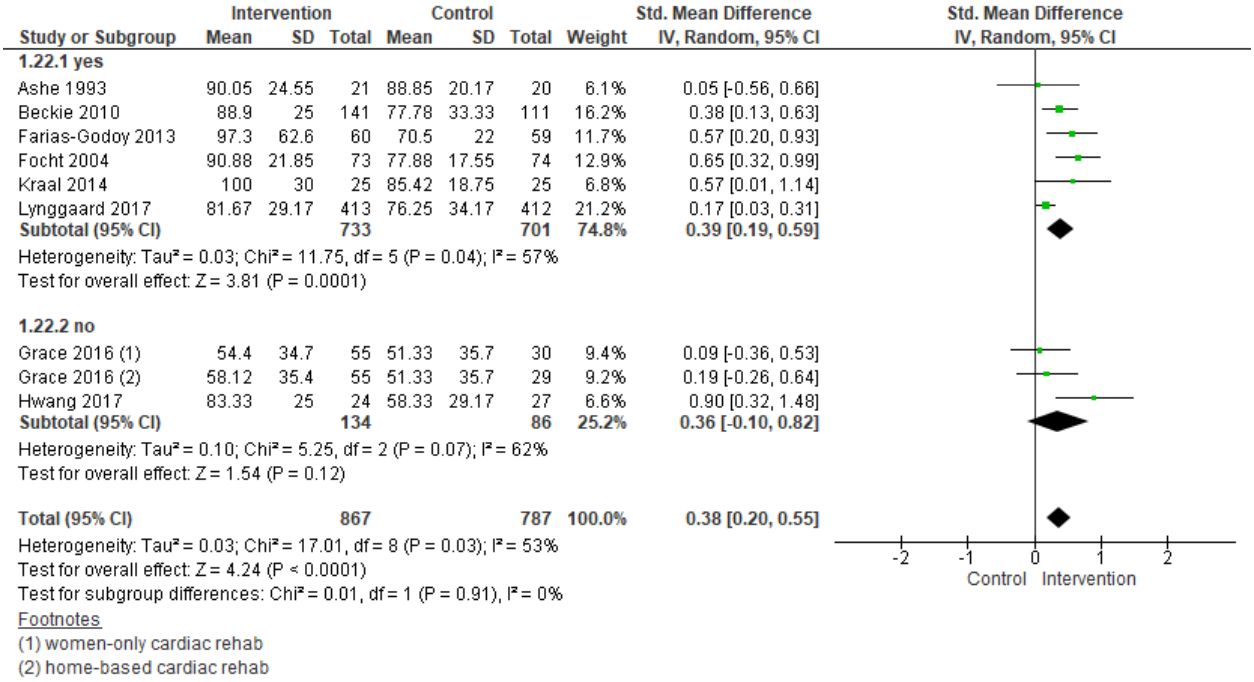
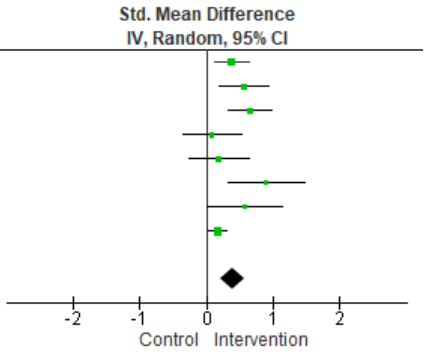


Figure 28**.** Comparison 1 CR utilization, Outcome 23 Adherence - sensitivity analysis - low risk of bias studies

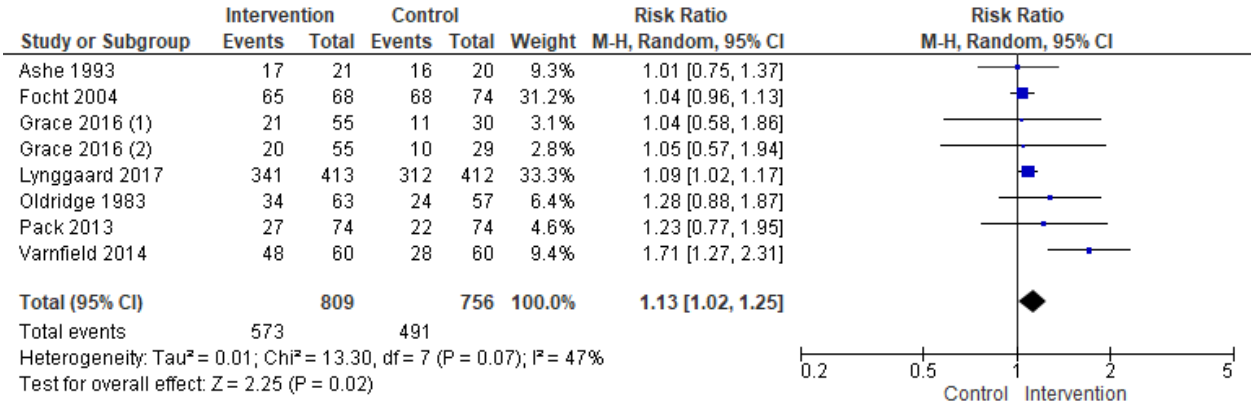
Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Beckie 2010	88.9	25	141	77.78	33.33	111	17.0%	0.38 [0.13, 0.63]
Farias-Godoy 2013	97.3	62.6	60	70.5	22	59	12.5%	0.57 [0.20, 0.93]
Focht 2004	90.88	21.85	73	77.88	17.55	74	13.8%	0.65 [0.32, 0.99]
Grace 2016 (1)	54.4	34.7	55	51.33	35.7	30	10.1%	0.09 [-0.36, 0.53]
Grace 2016 (2)	58.12	35.4	55	51.33	35.7	29	10.0%	0.19 [-0.26, 0.64]
Hwang 2017	83.33	25	24	58.33	29.17	27	7.2%	0.90 [0.32, 1.48]
Kraal 2014	100	30	25	85.42	18.75	25	7.4%	0.57 [0.01, 1.14]
Lynggaard 2017	81.67	29.17	413	76.25	34.17	412	22.0%	0.17 [0.03, 0.31]
Total (95% CI)			**846**			**767**	**100.0%**	**0.40 [0.21, 0.58]**

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 16.37$, df = 7 (P = 0.02); $I^2 = 57\%$
Test for overall effect: Z = 4.25 (P < 0.0001)



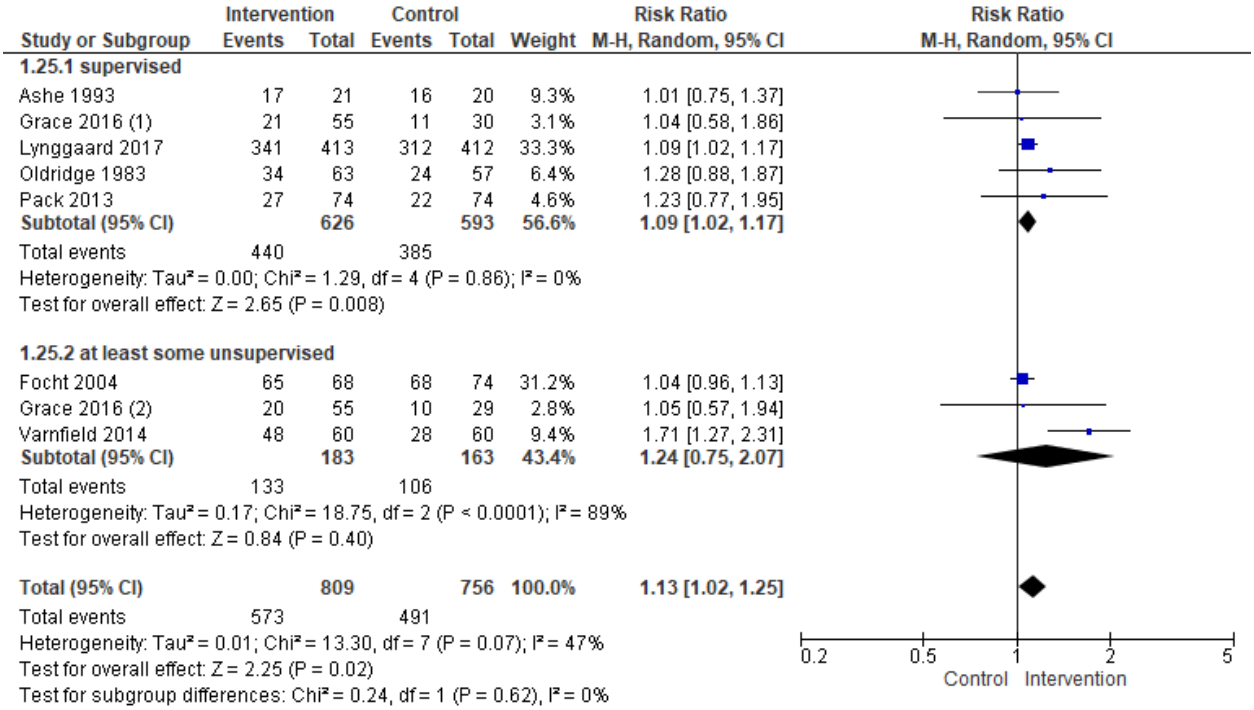
Footnotes
(1) women-only cardiac rehab
(2) home-based cardiac rehab

Figure 29**.** Comparison 1 CR utilization, Outcome 24 Completion



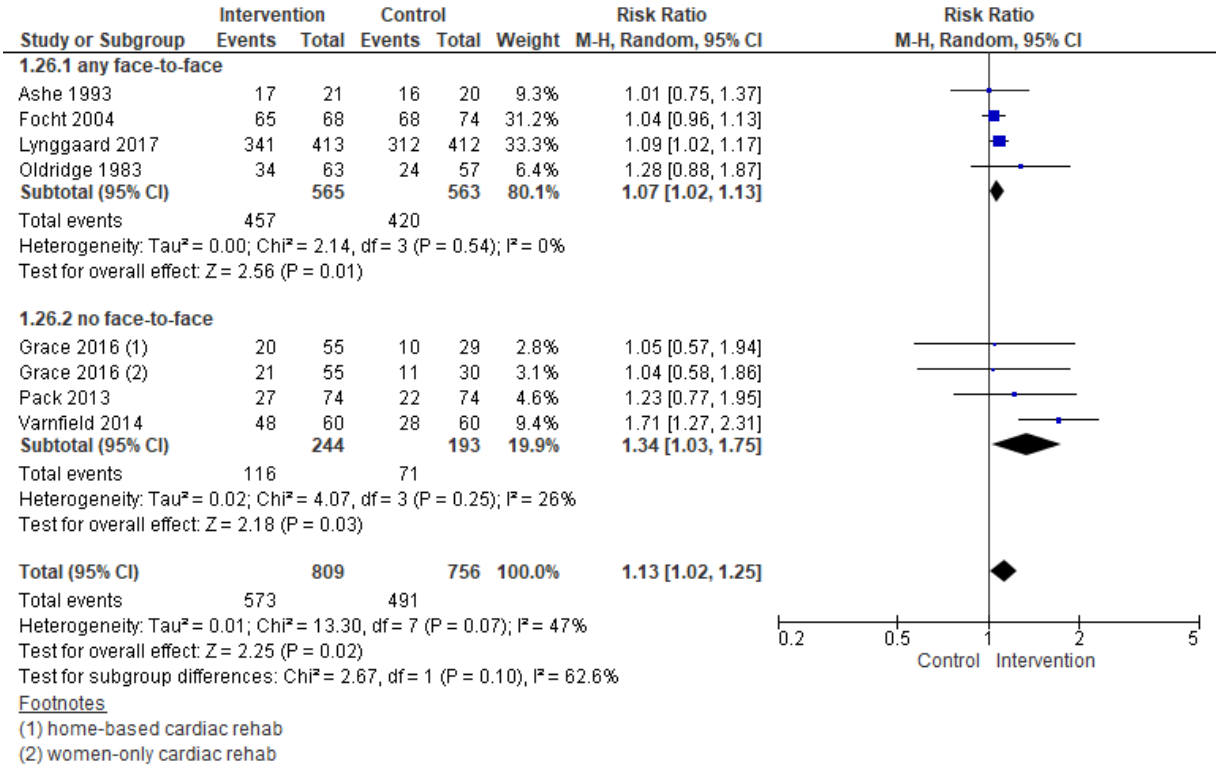
Footnotes
(1) women-only cardiac rehab
(2) home-based cardiac rehab

Figure 30**.** Comparison 1 CR utilization, Outcome 25 Completion - CR setting



Footnotes
(1) women-only cardiac rehab
(2) home-based cardiac rehab

Figure 31**.** Comparison 1 CR utilization, Outcome 26 Completion - delivery format

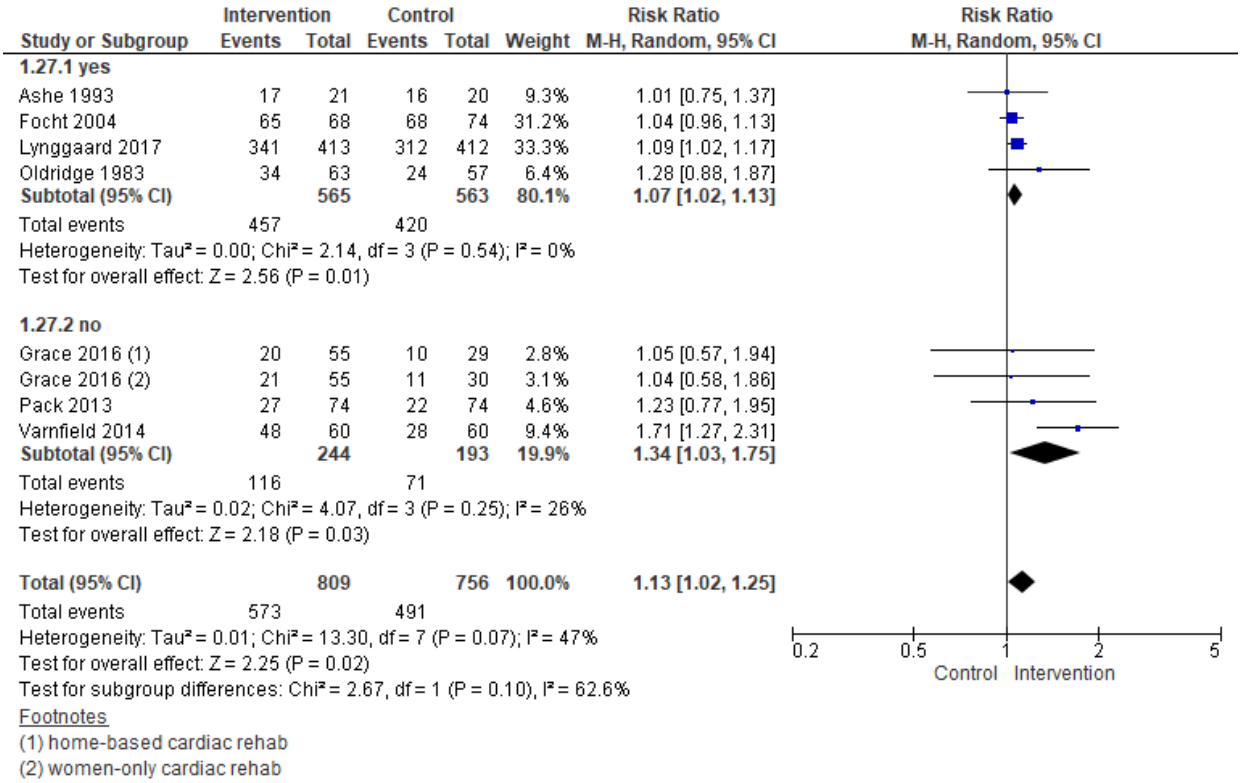


Footnotes

(1) home-based cardiac rehab

(2) women-only cardiac rehab

Figure 32**.** Comparison 1 CR utilization, Outcome 27 Completion - theory-based

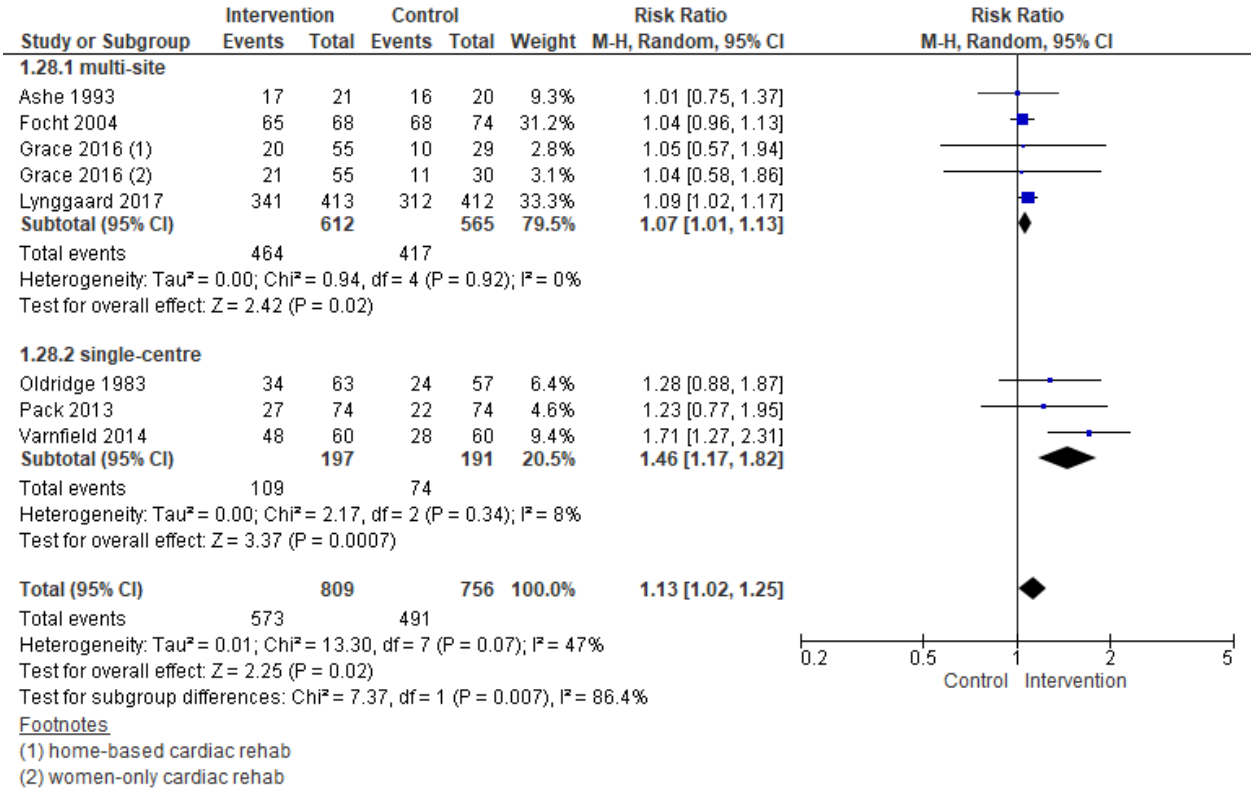


Footnotes

(1) home-based cardiac rehab

(2) women-only cardiac rehab

Figure 33**.** Comparison 1 CR utilization, Outcome 28 Completion - number of sites

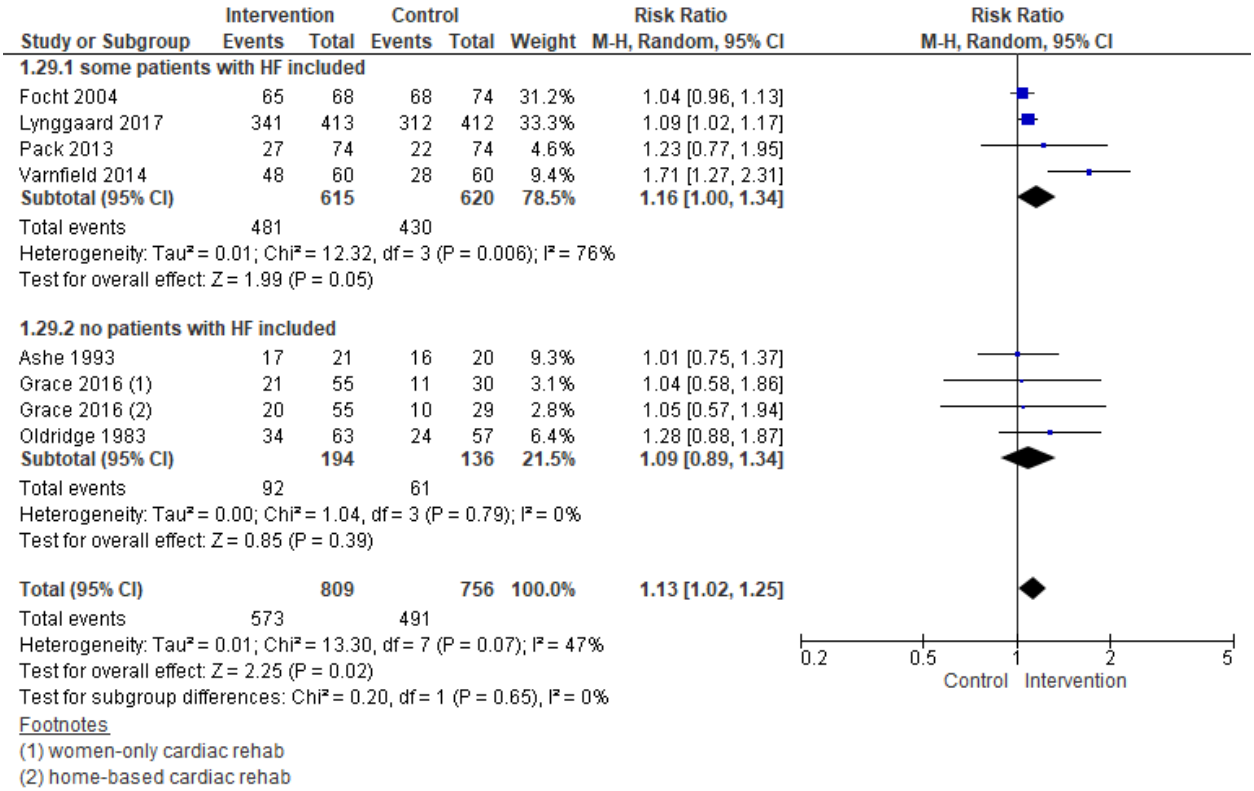


Footnotes

(1) home-based cardiac rehab

(2) women-only cardiac rehab

Figure 34**.** Comparison 1 CR utilization, Outcome 29 Completion - cardiac indication



Footnotes

(1) women-only cardiac rehab

(2) home-based cardiac rehab

Figure 35**.** Comparison 1 CR utilization, Outcome 30 Completion - region

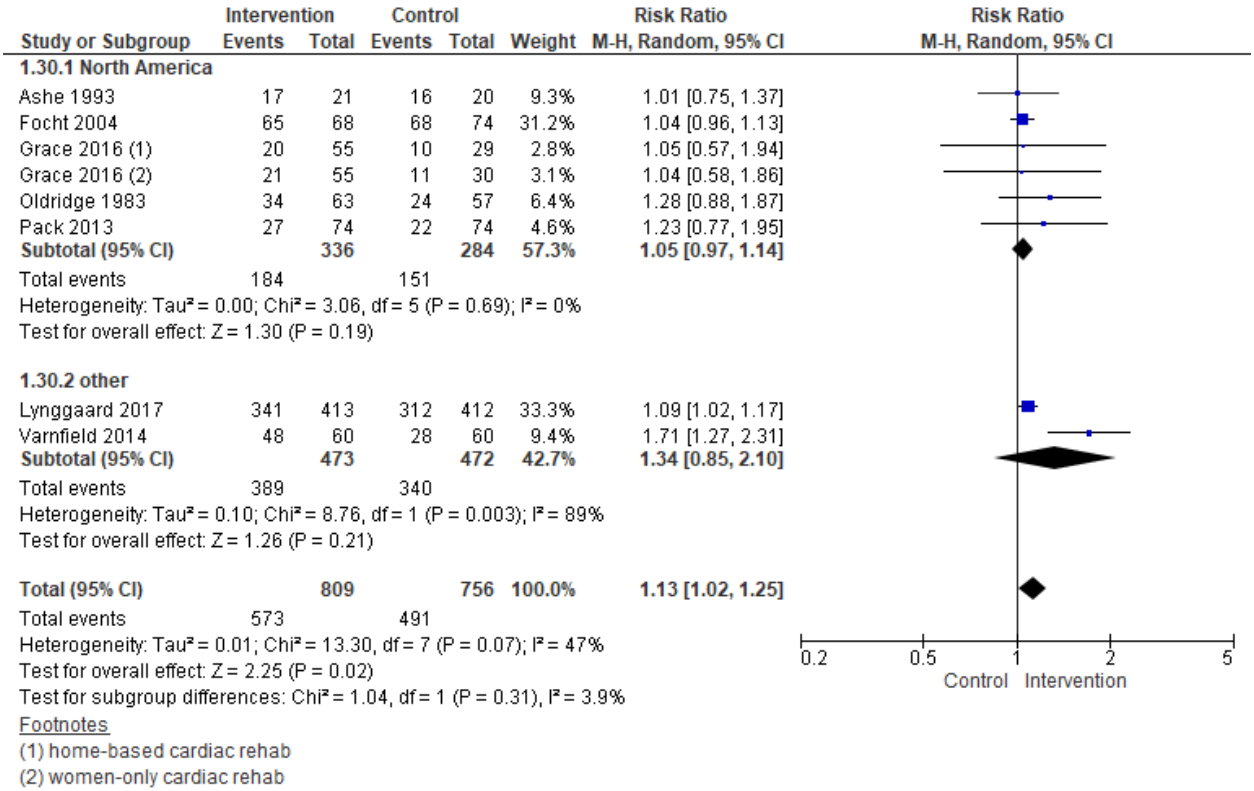
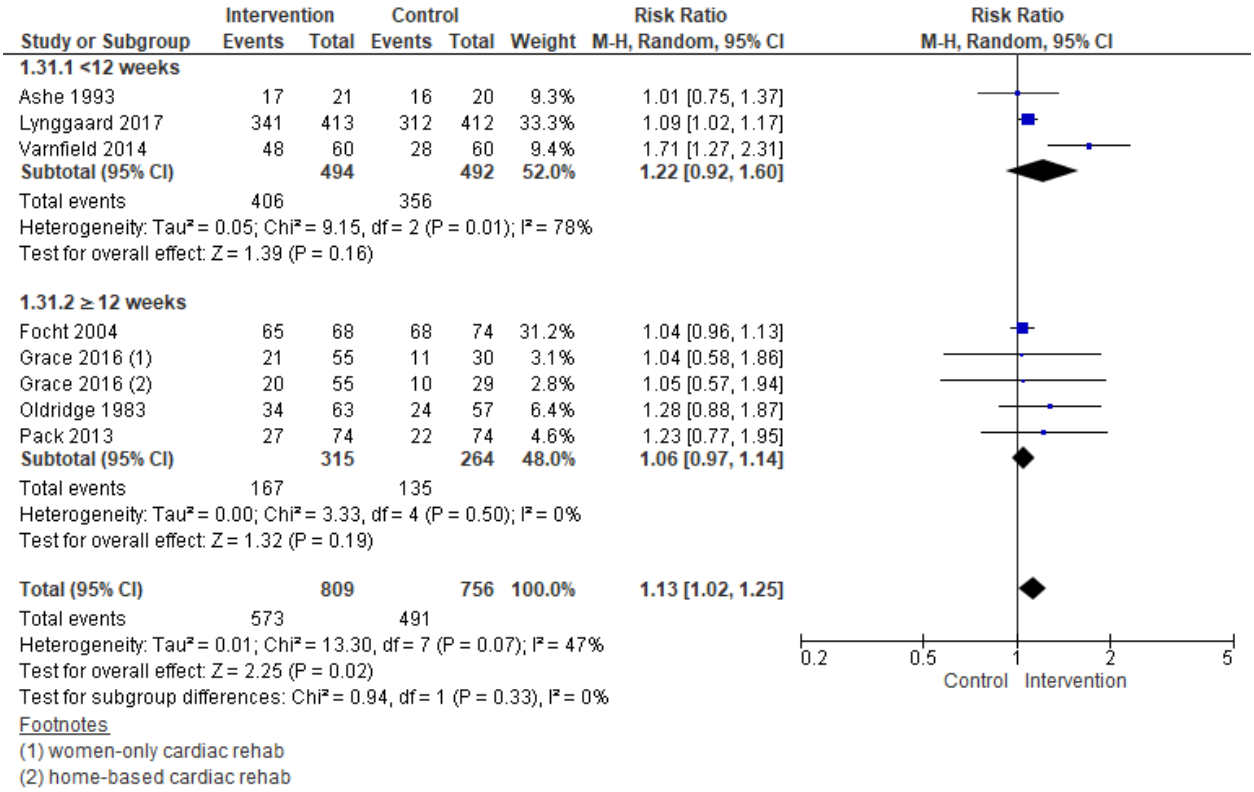


Figure 36**.** Comparison 1 CR utilization, Outcome 31 Completion - CR programme duration

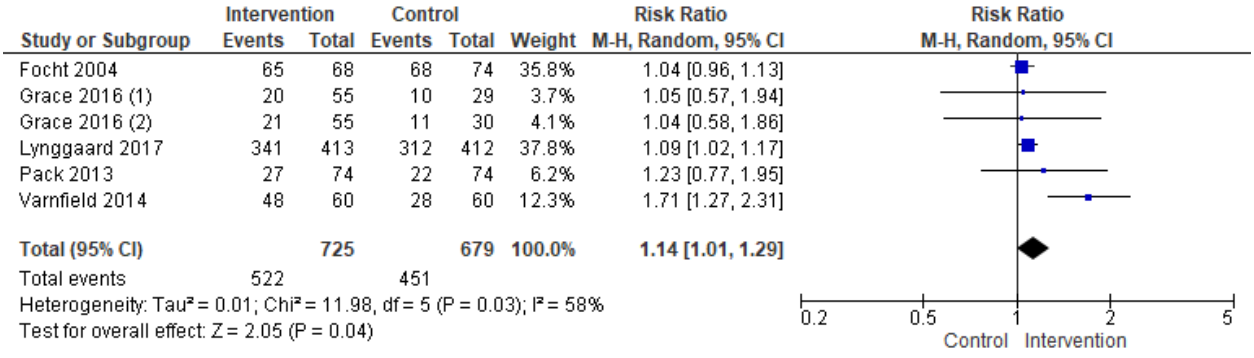


Footnotes

(1) women-only cardiac rehab

(2) home-based cardiac rehab

Figure 37**.** Comparison 1 CR utilization, Outcome 32 Completion - sensitivity analysis - low risk of bias studies



Footnotes

(1) home-based cardiac rehab

(2) women-only cardiac rehab

ADDITIONAL TABLES

Table 7. Meta-regression results

Outcome	Subgroup	Number of participants	Odds ratio (95% CI)	P	Residual I^2
Enrolment					
	Delivery format (any face-to-face or no face-to-face)	3096	0.73 (0.57 to 0.93)	0.01	37%
	Theory-based (yes or no)	3096	0.98 (0.75 to 1.27)	0.86	60%
	Outcome ascertainment (self-report or chart report)	1835	0.99 (0.99 to 1.00)	0.74	53%
	Number of sites (multi-site or single-centre)	943	0.90 (0.69 to 1.17)	0.40	60%
	Country (North America or other)	3096	0.91 (0.70 to 1.17)	0.44	60%
	Intervention intensity (< 5 contacts or ≥ 5 contacts)	2659	0.99 (0.99 to 1.00)	0.23	66%
	Peer navigation (yes or no)	3096	0.74 (0.50 to 1.10)	0.13	55%
	Intervention deliverer (nurse or allied healthcare professional or no one)	3096	0.73 (0.56 to 0.94)	0.02	37%
	Intervention target (patient or other)	3096	1.49 (0.98 to 2.28)	0.06	46%
	Cardiac indication (heart failure included or not)	2196	0.83 (0.63 to 1.10)	0.19	55%
	CR setting (supervised or unsupervised)	1650	1.03 (0.84 to 1.26)	0.76	15%

Appendix 1. Search strategies 2018

CENTRAL

#1 MESH DESCRIPTOR Myocardial Ischemia EXPLODE ALL
#2 myocard NEAR3 (ischemi* OR ischaemi*)*
#3 (ischemi OR ischaemi*) NEAR3 heart*
#4 MESH DESCRIPTOR Coronary Artery Bypass EXPLODE ALL
*#5 coronary NEAR3 bypass**
*#6 heart NEAR3 bypass**
#7 MESH DESCRIPTOR Coronary Disease EXPLODE ALL
#8 MESH DESCRIPTOR Myocardial Revascularization EXPLODE ALL
#9 MESH DESCRIPTOR Myocardial Infarction EXPLODE ALL
#10 myocard NEAR3 infarct**
*#11 heart NEAR3 infarct**
#12 cardia NEAR3 infarct**
*#13 acute NEAR3 infarct**
#14 ami
#15 angina
#16 MESH DESCRIPTOR Angina Pectoris EXPLODE ALL
#17 MESH DESCRIPTOR Heart Failure EXPLODE ALL
#18 ((cardiac or myocardial) NEAR1 (failure or insufficiency))
#19 heart NEAR3 (failure or attack)
#20 MESH DESCRIPTOR Percutaneous Coronary Intervention EXPLODE ALL
#21 cabg
#22 ptca
#23 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17
OR #18 OR #19 OR #20 OR #21 OR #22
#24 MESH DESCRIPTOR Patient Compliance EXPLODE ALL
#25 increase NEAR10 participat**
#26 comply
*#27 remain**
#28 adhere OR nonadhere**
#29 uptake
#30 sign NEAR2 (up OR on)
*#31 effectiv**
#32 "follow up"
*#33 engage**
*#34 attend**
#35 #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
#36 MESH DESCRIPTOR Rehabilitation Centers
#37 MESH DESCRIPTOR Rehabilitation EXPLODE ALL
*#38 rehabilitat**
#39 MESH DESCRIPTOR Sports
#40 MESH DESCRIPTOR Physical Exertion EXPLODE ALL
#41 MESH DESCRIPTOR Exercise EXPLODE ALL
#42 (physical NEAR3 (fit* OR train* OR therap* OR activit*))*

*#43 physiotherap**
#44 (train NEAR3 (strength* OR aerobic OR exercise*))*
#45 ((exercise OR fitness) NEAR3 (treatment OR intervent* OR program*))*

#46 MESH DESCRIPTOR Patient Education as Topic EXPLODE ALL
#47 (patient NEAR3 educat*)*
#48 ((lifestyle OR "life-style") NEAR3 (intervent OR program* OR treatment*))*
#49 MESH DESCRIPTOR Health Education EXPLODE ALL
#50 ((nutrition OR diet OR health) NEAR3 education)
#51 MESH DESCRIPTOR Self Care EXPLODE ALL
#52 (self NEAR3 (manage OR care))*
#53 MESH DESCRIPTOR Motivation EXPLODE ALL
*#54 motivat**
#55 "heart manual"
#56 MESH DESCRIPTOR Ambulatory Care EXPLODE ALL
#57 MESH DESCRIPTOR Psychotherapy EXPLODE ALL
*#58 psychotherap**
#59 psycholog NEAR3 intervent**
#60 MESH DESCRIPTOR Mind-Body Therapies EXPLODE ALL
*#61 relax**
*#62 meditat**
*#63 autogenic**
*#64 hypnotherap**
#65 MESH DESCRIPTOR Counseling EXPLODE ALL
#66 counseling OR counselling
#67 MESH DESCRIPTOR Behavior Therapy EXPLODE ALL
#68 (behavior OR behaviour*) NEAR4 (modif* OR therap* OR rehab* OR change)*
#69 cogniti NEAR3 therap**
#70 cbt
#71 MESH DESCRIPTOR Stress, Psychological EXPLODE ALL
#72 (stress NEAR3 manage)*
#73 MESH DESCRIPTOR Anxiety
#74 manage NEAR3 (anxiety OR depres*)*
#75 goal NEAR3 setting
#76 "psycho-educat"*
#77 motivat NEAR3 interv**
#78 MESH DESCRIPTOR Psychopathology EXPLODE ALL
*#79 psychopathol**
*#80 distress**
#81 psychosocial OR "psycho-social*"*
#82 secondary NEAR5 prevent NEAR10 (intervent* OR program* OR treatment* OR plan* OR regimen*)*
#83 #82 OR #81 OR #80 OR #79 OR #78 OR #77 OR #76 OR #75 OR #74 OR #73 OR #72 OR #71 OR #70 OR #69 OR #68 OR #
67 OR #66 OR #65 OR #64 OR #63 OR #62 OR #61 OR #60 OR #59 OR #58 OR #57 OR #56 OR #55 OR #54 OR #53 OR #52 OR
#51 OR #50 OR #49 OR #48 OR #47 OR #46 OR #45 OR #44 OR #43 OR #42 OR #41 OR #40 OR #39 OR #38 OR #37 OR #36
#84 MESH DESCRIPTOR Heart Diseases EXPLODE ALL WITH QUALIFIER RH
#85 #83 AND #23

#86 #84 OR #85
#87 #86 AND #35
#88 #87 Publication Year from 2013 to 2018

MEDLINE Ovid

1 exp Myocardial Ischemia/
2 (myocard adj3 isch?emi*).tw.*
3 (isch?emi adj3 heart).tw.*
4 exp Coronary Artery Bypass/
5 coronary.tw.
6 (heart adj3 bypass).tw.*
7 exp Coronary Disease/
8 exp Myocardial Revascularization/
9 exp Myocardial Infarction/
10 (myocard adj3 infarct*).tw.*
11 (heart adj3 infarct).tw.*
12 (cardia adj3 infarct*).tw.*
13 (acute adj3 infarct).tw.*
14 AMI.tw.
15 exp Angina Pectoris/
16 angina.tw.
17 exp Heart Failure/
18 ((cardiac or myocardial) adj (failure or insufficiency)).tw.
19 (heart adj3 (failure or attack)).tw.
20 exp Percutaneous Coronary Intervention/
21 CABG.tw.
22 (PTCA or PCI).tw.
23 or/1-22
24 Patient Compliance/
25 (increase adj10 participat*).tw.*
26 (comply or complian or noncomplian*).tw.*
27 remain.tw.*
28 (adhere or nonadhere*).tw.*
29 (uptake or take up).tw.
30 (sign adj2 (up or on)).tw.
31 effectiv.tw.*
32 follow up.tw.
33 engage.tw.*
34 attend.tw.*
35 or/24-34
36 Rehabilitation Centers/
37 exp Rehabilitation/
38 rehabilitat.tw.*
39 Sports/
40 exp Physical Exertion/
41 exp Exercise/
42 (physical adj3 (fit* or train* or therap* or activit*)).tw.*
43 physiotherap.tw.*

44 (train adj3 (strength* or aerobic or exercise*)).tw.*
45 ((exercise or fitness) adj3 (treatment or intervent* or program*)).tw.*
46 exp Patient Education as Topic/
47 (patient adj3 educat*).tw.*
48 ((lifestyle or life-style) adj3 (intervent or program* or treatment*)).tw.*
49 exp Health Education/
50 ((nutrition or diet or health) adj3 education).tw.
51 exp Self Care/
52 (self adj3 (manage or care)).tw.*
53 exp Motivation/
54 motivat.tw.*
55 heart manual.tw.
56 exp Ambulatory Care/
57 exp Psychotherapy/
58 psychotherap.tw.*
59 (psycholog adj3 intervent*).tw.*
60 exp Mind-Body Therapies/
61 relax.tw.*
62 meditat.tw.*
63 autogenic.tw.*
64 hypnotherap.tw.*
65 exp Counseling/
66 counsel?ing.tw.
67 exp Behavior Therapy/
68 (behavio?r adj4 (modif* or therap* or rehab* or change)).tw.*
69 (cogniti adj3 therap*).tw.*
70 CBT.tw.
71 exp Stress, Psychological/
72 (stress adj3 manage).tw.*
73 Anxiety/
74 (manage adj3 (anxiety or depres*)).tw.*
75 (goal adj3 setting).tw.
76 (psycho-educat or psychoeducat*).tw.*
77 (motivat adj3 interv*).tw.*
78 exp Psychopathology/
79 psychopathol.tw.*
80 distress.tw.*
81 (psychosocial or psycho-social*).tw.*
82 (secondary adj5 prevent adj10 (intervent* or program* or treatment* or plan* or regimen*)).tw.*
83 or/36-82
84 Cardiac Rehabilitation/
85 exp Heart Diseases/rh [Rehabilitation]
86 84 or 85
87 23 and 83
88 86 or 87
89 35 and 88
90 randomized controlled trial.pt.
91 controlled clinical trial.pt.
92 randomized.ab.

93 placebo.ab.
94 drug therapy.fs.
95 randomly.ab.
96 trial.ab.
97 groups.ab.
98 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97
99 exp animals/ not humans.sh.
100 98 not 99
101 89 and 100
102 limit 101 to ed=20130101-20180710

Embase Elsevier (2013 to April 2017)

1. 'heart muscle ischemia'/exp
2. (myocard* NEAR/3 isch*emi*):ab,ti
3. (isch*emi* NEAR/3 heart):ab,ti
4. 'coronary artery bypass graft'/de
5. (coronary NEAR/3 bypass*):ab,ti
6. (heart NEAR/3 bypass*):ab,ti
7. 'coronary artery disease'/exp
8. 'heart muscle revascularization'/de
9. 'heart infarction'/exp
10. (myocard* NEAR/3 infarct*):ab,ti
11. (heart NEAR/3 infarct*):ab,ti
12. (cardia* NEAR/3 infarct*):ab,ti
13. (acute NEAR/3 infarct*):ab,ti
14. ami:ab,ti
15. 'angina pectoris'/exp
16. angina:ab,ti
17. 'heart failure'/exp
18. ((cardiac OR myocardial) NEAR/1 (failure OR insufficiency)):ab,ti
19. (heart NEAR/3 (failure OR attack)):ab,ti
20. 'percutaneous coronary intervention'/exp
21. cabg:ab,ti
22. ptca:ab,ti OR pci:ab,ti
23. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22
24. 'patient compliance'/de
25. (increase* NEAR/10 participat*):ab,ti
26. comply:ab,ti OR complian*:ab,ti OR noncomplian*:ab,ti
27. remain*:ab,ti
28. adhere*:ab,ti OR nonadhere*:ab,ti
29. uptake:ab,ti OR 'take up':ab,ti
30. (sign NEAR/2 (up OR on)):ab,ti.
31. effectiv*:ab,ti
32. 'follow up':ab,ti
33. engage*:ab,ti
34. attend*:ab,ti

35. #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
36. 'rehabilitation center'/de
37. 'rehabilitation'/exp
38. rehabilitat*:ab,ti
39. 'sport'/de
40. 'exercise'/exp
41. (physical* NEAR/3 (fit* OR train* OR therap* OR activit*)):ab,ti
42. physiotherap*:ab,ti
43. (train* NEAR/3 (strength* OR aerobic OR exercise*)):ab,ti
44. ((exercise* OR fitness) NEAR/3 (treatment OR intervent* OR program*)):ab,ti
45. 'patient education'/de
46. (patient* NEAR/3 educat*):ab,ti
47. ((lifestyle OR 'life-style') NEAR/3 (intervent* OR program* OR treatment*)):ab,ti
48. 'health education'/exp
49. ((nutrition OR diet OR health) NEAR/3 education):ab,ti
50. 'self care'/exp
51. (self NEAR/3 (manage* OR care)):ab,ti
52. 'motivation'/de
53. motivat*:ab,ti
54. motivat*:ab,ti
55. 'ambulatory care'/exp
56. 'psychotherapy'/exp
57. psychotherap*:ab,ti
58. (psycholog* NEAR/3 intervent*):ab,ti
59. 'alternative medicine'/exp
60. relax*:ab,ti
61. meditat*:ab,ti
62. autogenic*:ab,ti
63. hypnotherap*:ab,ti
64. 'counseling'/exp
65. counsel*ing:ab,ti
66. 'behavior therapy'/exp
67. (behavio*r* NEAR/4 (modif* OR therap* OR rehab* OR change)):ab,ti
68. (cogniti* NEAR/3 therap*):ab,ti
69. cbt:ab,ti
70. 'mental stress'/de
71. (stress NEAR/3 manage*):ab,ti
72. 'anxiety'/de
73. (manage* NEAR/3 (anxiety OR depres*)):ab,ti
74. (goal NEAR/3 setting):ab,ti
75. 'psycho-educat*':ab,ti OR psychoeducat*:ab,ti
76. (motivat* NEAR/3 interv*):ab,ti
77. psychopathol*:ab,ti
78. distress*:ab,ti
79. psychosocial*:ab,ti OR 'psycho-social*':ab,ti
80. (secondary NEAR/5 prevent* NEAR/10 (intervent* OR program* OR treatment* OR plan* OR regimen*)):ab,ti
81. #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50

OR #51 OR #52 OR #53OR #54 OR #55 OR #56 OR #57 OR #58 OR #59 OR #60 OR #61 OR #62 OR #63 OR #64 OR #65
OR #66 OR #67 OR #68 OR #69 OR #70 OR #71 OR #72 OR #73 OR #74 OR #75 OR #76 OR #77 OR #78 OR #79 OR #80
82. 'heart rehabilitation'/de
83. 'heart disease'/exp/dm˙rh
84. #82 OR #83
85. #23 AND #81
86. #84 OR #85
87. #35 AND #86
88. random*:ab,ti OR placebo* OR (double NEXT/1 blind*):ab,ti
89. #87 AND #88 AND [1-1-2013]/sd NOT [23-4-2017]/sd
90. #89 AND [embase]/lim NOT [medline]/lim

Embase Ovid (April 2017 to July 2018)

1 exp heart muscle ischemia/
2 (myocard adj3 isch?emi*).tw.*
3 (isch?emi adj3 heart).tw.*
4 exp coronary artery bypass graft/
5 (coronary adj3 bypass).tw.*
6 (heart adj3 bypass).tw.*
7 exp coronary artery disease/
8 exp heart muscle revascularization/
9 exp heart infarction/
10 (myocard adj3 infarct*).tw.*
11 (heart adj3 infarct).tw.*
12 (cardia adj3 infarct*).tw.*
13 (acute adj3 infarct).tw.*
14 AMI.tw.
15 exp angina pectoris/
16 angina.tw.
17 exp heart failure/
18 ((cardiac or myocardial) adj (failure or insufficiency)).tw.
19 (heart adj3 (failure or attack)).tw.
20 exp percutaneous coronary intervention/
21 CABG.tw.
22 (PTCA or PCI).tw.
23 or/1-22
24 patient compliance/
25 (increase adj10 participat*).tw.*
26 (comply or complian or noncomplian*).tw.*
27 remain.tw.*
28 (adhere or nonadhere*).tw.*
29 (uptake or take up).tw.
30 (sign adj2 (up or on)).tw.
31 effectiv.tw.*
32 follow up.tw.
33 engage.tw.*

34 attend.tw.*
35 or/24-34
36 rehabilitation center/
37 exp rehabilitation/
38 rehabilitat.tw.*
39 sport/
40 exp exercise/
41 (physical adj3 (fit* or train* or therap* or activit*)).tw.*
42 physiotherap.tw.*
43 (train adj3 (strength* or aerobic or exercise*)).tw.*
44 ((exercise or fitness) adj3 (treatment or intervent* or program*)).tw.*
45 patient education/
46 (patient adj3 educat*).tw.*
47 ((lifestyle or life-style) adj3 (intervent or program* or treatment*)).tw.*
48 exp health education/
49 ((nutrition or diet or health) adj3 education).tw.
50 exp self care/
51 (self adj3 (manage or care)).tw.*
52 exp motivation/
53 motivat.tw.*
54 heart manual.tw.
55 exp ambulatory care/
56 exp psychotherapy/
57 psychotherap.tw.*
58 (psycholog adj3 intervent*).tw.*
59 exp alternative medicine/
60 relax.tw.*
61 meditat.tw.*
62 autogenic.tw.*
63 hypnotherap.tw.*
64 exp counseling/
65 counsel?ing.tw.
66 exp behavior therapy/
67 (behavio?r adj4 (modif* or therap* or rehab* or change)).tw.*
68 (cogniti adj3 therap*).tw.*
69 CBT.tw.
70 mental stress/
71 (stress adj3 manage).tw.*
72 anxiety/
73 (manage adj3 (anxiety or depres*)).tw.*
74 (goal adj3 setting).tw.
75 (psycho-educat or psychoeducat*).tw.*
76 (motivat adj3 interv*).tw.*
77 psychopathol.tw.*
78 distress.tw.*
79 (psychosocial or psycho-social*).tw.*
80 (secondary adj5 prevent adj10 (intervent* or program* or treatment* or plan* or regimen*)).tw.*
81 or/36-80
82 heart rehabilitation/

83 exp heart disease/rh [Rehabilitation]
84 82 or 83
85 23 and 81
86 84 or 85
87 35 and 86
88 random$.tw.
89 factorial$.tw.
90 crossover$.tw.
91 cross over$.tw.
92 cross-over$.tw.
93 placebo$.tw.
94 (doubl$ adj blind$).tw.
95 (singl$ adj blind$).tw.
96 assign$.tw.
97 allocat$.tw.
98 volunteer$.tw.
99 crossover procedure/
100 double blind procedure/
101 randomized controlled trial/
102 single blind procedure/
103 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
104 (animal/ or nonhuman/) not human/
105 103 not 104
106 87 and 105
107 limit 106 to embase
108 limit 107 to em=201714-201828

CINAHL

S95 S94 AND EM 201301-
S94 S89 AND S93
S93 S90 OR S91 OR S92
S92 PT clinical trial
S91 (MH “Treatment Outcomes”)
S90 TI randomized or AB randomized
S89 S35 AND S88
S88 S86 OR S87
S87 S23 AND S83
S86 S84 AND S85
S85 (MH “Heart Diseases+/RH”)
S84 (MH “Rehabilitation, Cardiac+”)
S83 S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50
OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65
OR S66 OR S67 OR S68 OR S69 OR S70 OR S71 OR S72 OR S73 OR S74 OR S75 OR S76 OR S77 OR S78 OR S79 OR S80
OR S81 OR S82

S82 TI ((secondary N5 prevent* N10 (intervent* or program* or treatment* or plan* or regimen*))) OR AB ((secondary N5 prevent*
N10 (intervent* or program* or treatment* or plan* or regimen*)))
S81 TI ((psychosocial* or “psycho-social*”)) OR AB ((psychosocial* or “psycho-social*”))
S80 TI distress* OR AB distress*
S79 TI psychopathol* OR AB psychopathol*
S78 (MH “Psychopathology”)
S77 TI (motivat* N3 interv*) OR AB (motivat* N3 interv*)
S76 TI ((psycho-educat* or psychoeducat*)) OR AB ((psycho-educat* or psychoeducat*))
S75 TI (goal N3 setting) OR AB (goal N3 setting)
S74 TI ((manage* N3 (anxiety or depres*))) OR AB ((manage* N3 (anxiety or depres*)))
S73 (MH “Anxiety+”)
S72 TI (stress N3 manage*) OR AB (stress N3 manage*)
S71 (MH “Stress, Psychological+”)
S70 TI CBT OR AB CBT
S69 TI (cogniti* N3 therap*) OR AB (cogniti* N3 therap*)
S68 TI ((behavio#r* N4 (modif* or therap* or rehab* or change))) OR AB ((behavio#r* N4 (modif* or therap* or rehab* or change))
)
S67 (MH “Behavior Therapy+”)
S66 TI counsel#ing OR AB counsel#ing
S65 (MH “Counseling+”)
S64 TI hypnotherap* OR AB hypnotherap*
S63 TI autogenic* OR AB autogenic*
S62 TI meditat* OR AB meditat*
S61 TI relax* OR AB relax*
S60 (MH “Mind Body Techniques+”)
S59 TI (psycholog* N3 intervent*) OR AB (psycholog* N3 intervent*)
S58 TI psychotherap* OR AB psychotherap*
S57 (MH “Psychotherapy+”)
S56 (hypnotherap* (MH “Ambulatory Care”))
S55 TI “heart manual” OR AB “heart manual”
S54 TI motivat* OR AB motivat*
S53 (MH “Motivation+”)
S52 TI ((self N3 (manage* or care))) OR AB ((self N3 (manage* or care)))
S51 (MH “Self Care”)
S50 TI (((nutrition or diet or health) N3 education)) OR AB (((nutrition or diet or health) N3 education)
)
S49 (MH “Health Education”) OR (MH “Nutrition Education”)
S48 TI (((lifestyle or “life-style”) N3 (intervent* or program* or treatment*))) OR AB (((lifestyle or “life-style”) N3 (intervent* or
program* or treatment*)))
S47 TI (patient* N3 educat*) OR AB (patient* N3 educat*)
S46 (MH “Patient Education”) OR (MH “Patient Discharge Education”)
S45 TI (((exercise* or fitness) N3 (treatment or intervent* or program*))) OR AB (((exercise* or fitness) N3 (treatment or intervent*
or program*)))
S44 TI ((train* N3 (strength* or aerobic or exercise*))) OR AB ((train* N3 (strength* or aerobic or exercise*)))

S43 TI physiotherap* OR AB physiotherap*
S42 TI ((physical* N3 (fit* or train* or therap* or activit*))) OR AB ((physical* N3 (fit* or train* or therap* or activit*)))
S41 (MH "Physical Activity")
S40 (MH "Exertion+")
S39 (MH "Sports")
S38 TI rehabilitat* OR AB rehabilitat*
S37 (MH "Rehabilitation+")
S36 (MH "Rehabilitation Centers")
S35 S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34
S34 TI attend* OR AB attend*
S33 TI engage* OR AB engage*
S32 TI "follow up" OR AB "follow up"
S31 TI effectiv* OR AB effectiv*
S30 TI ((sign N2 (up or on))) OR AB ((sign N2 (up or on)))
S29 TI ((uptake or "take up")) OR AB ((uptake or "take up"))
S28 TI ((adhere* or nonadhere*)) OR AB ((adhere* or nonadhere*))
S27 TI remain* OR AB remain*
S26 TI ((comply or complian* or noncomplian*)) OR AB ((comply or complian* or noncomplian*))
S25 TI (increase* N10 participat*) OR AB (increase* N10 participat*)
S24 (MH "Patient Compliance")
S23 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR
S17 OR S18 OR S19 OR S20 OR S21 OR S22
S22 TI ((PTCA or PCI)) OR AB ((PTCA or PCI))
S21 TI CABG OR AB CABG
S20 (MH "Angioplasty, Balloon+")
S19 TI ((heart N3 (failure or attack))) OR AB ((heart N3 (failure or attack)))
S18 TI (((cardiac or myocardial) N1 (failure or insufficiency))) OR AB (((cardiac or myocardial) N1 (failure or insufficiency)))
S17 (MH "Heart Failure+")
S16 TI angina OR AB angina
S15 (MH "Angina Pectoris+")
S14 TI (AMI) OR AB (AMI)
S13 TI (acute N3 infarct*) OR AB (acute N3 infarct*)
S12 TI (cardia* N3 infarct*) OR AB (cardia* N3 infarct*)
S11 TI (heart N3 infarct*) OR AB (heart N3 infarct*)
S10 TI (myocard* N3 infarct*) OR AB (myocard* N3 infarct*)
S9 (MH "Myocardial Infarction+")
S8 (MH "Myocardial Revascularization+")
S7 (MH "Coronary Disease+")
S6 TI (heart N3 bypass*) OR AB (heart N3 bypass*)
S5 TI coronary OR AB coronary
S4 (MH "Coronary Artery Bypass+")
S3 TI (isch#emi* N3 heart) OR AB (isch#emi* N3 heart)
S2 TI (myocard* N3 isch#emi*) OR AB (myocard* N3 isch#emi*)
S1 (MH "Myocardial Ischemia+")

CPCI - Science (WoS)

32 #31 Timespan=2013-2018
31 #29 and #30
30 TS=((random* or blind* or allocat* or assign* or trial* or placebo* or crossover* or “cross-over*”))
29 #9 and #13 and #28
28 #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27
27 TS=(secondary near/5 prevent* near/10 (intervent* or program* or treatment* or plan* or regimen*))
26 TS=(goal near/3 setting)
25 TS=(manage* near/3 (anxiety or depres* or stress))
24 TS=(cogniti* near/3 therap*)
23 TS=(behavio$r* near/4 (modif* or therap* or rehab* or change))
22 TS=(psycholog* near/3 intervent*)
21 TS=(physiotherap* or “mind body therap*” or motivat* or “heart manual” or “ambulatory care” or psychotherap* or relax* or
meditat* or autogenic* or hypnotherap* or counseling or CBT or “psycho-educat*” or psychoeducat* or psychopathol* or distress* or
psychosocial* or “psycho-social*”)
20 TS=((lifestyle or “life-style”) near/3 (intervent* or program* or treatment*))
19 TS=(self near/3 (manage* or care))
18 TS=((patient* or nutrition or diet or health) near/3 education)
17 TS=((exercise* or fitness) near/3 (treatment or intervent* or program*))
16 TS=(train* near/3 (strength* or aerobic or exercise*))
15 TS=(physical* near/3 (fit* or train* or therap* or activit* or exert*))
14 TS=(rehabilitat*)
13 #10 or #11 or #12
12 TS=(sign near/2 (up or on))
11 TS=(comply or complian* or noncomplian* or remain* or adhere* or nonadhere* or uptake or “take up” or effectiv* or “follow
up” or engage* or attend*)
10 TS=(increase* near/10 participat*)
9 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8
8 TS=(heart near/3 (failure or attack))
7 TS=((cardiac or myocardial) near/1 (failure or insufficiency))
6 TS=(AMI or angina or CABG or “percutaneous coronary intervention” OR PCI or PTCA or angioplast*)
5 TS=(myocard* near/3 revascularization)
4 TS=((myocard* or heart or cardia* or acute) near/3 infarct*)
3 TS=(heart near/3 bypass*)
2 TS=(coronary)
1 TS=((myocard* or heart) near/3 isch$emi*)

CHAPTER 3

Promoting patient utilization of outpatient cardiac rehabilitation: A joint International Council and Canadian Association of Cardiovascular Prevention and Rehabilitation Position Statement

CHAPTER 3: STUDY 2

CERTIFICATE OF AUTHENTIFICATION

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Endorsed by: American Society for Preventive Cardiology, Australian Cardiovascular Health and Rehabilitation Association, Brazilian Association of Cardiorespiratory and Intensive Care Physiotherapy, Brazilian Group of Cardiopulmonary and Metabolic Rehabilitation, Association Francophone de Cardiologie Préventive, British Association for Cardiovascular Prevention and Rehabilitation, Canadian Association of Cardiovascular Prevention and Rehabilitation, Canadian Council of Cardiovascular Nurses, Canadian Cardiovascular Society, Cardiac Health Foundation of Canada, Indonesian Heart Association, International Council of Cardiovascular Prevention and Rehabilitation, Iranian Heart Foundation, Nepal Physiotherapy Society, Philippine Heart Association, Preventive Cardiovascular Nurses Association, Russian National Society of Preventive Cardiology, Society of Indian Physiotherapists, South African Sports Medicine Association, Taiwan Academy of Physical Medicine and Rehabilitation.

Author	Contribution
Santiago de A. Pio, C.	- conception and design of the project (50%) - recommendations draft (50%) - manuscript writing (20%) - organized voting and rating of recommendations (100%) - sought endorsement from major cardiac societies (80%) - posting draft for public consideration (100%)
Beckie, T., Sarrafzadegan, N., Babu, A., Baidya, S., Buckley, J., Chen, S-Y., Gagliardi, A.,	- input into outline (40%) - recommendations ratings and consensus (100%) - critically revising the manuscript for important intellectual content (100%)

Heine, M., Khiong, J.S., Mola, A., Radi, B., Supervia, M., Trani, M.R., Varnfield, M., Abreu, A.	
Sawdon, J., Moffatt, P.D.	- recommendations ratings and consensus (100%) - critically revising the manuscript for important intellectual content (100%) - patient perspective on recommendations and guideline implementation tool (100%)
Grace, S.L.	- conception and design of the project (50%) - sought endorsement from major cardiac societies (20%) - manuscript writing (80%) - providing final approval of the manuscript (100%)

Promoting patient utilization of outpatient cardiac rehabilitation: A joint International Council and Canadian Association of Cardiovascular Prevention and Rehabilitation Position Statement

ABSTRACT

Purpose: Cardiac Rehabilitation (CR) is a recommendation in international clinical practice guidelines given its' benefits, however use is suboptimal. The purpose of this position paper was to translate evidence on interventions that increase CR enrolment and adherence into implementable recommendations.

Methods: The writing panel was constituted by representatives of societies internationally concerned with preventive cardiology, and included disciplines that would be implementing the recommendations. Patient partners served, as well as policy-makers. The statement was developed in accordance with AGREE II, among other guideline checklists. Recommendations were based on our update of the Cochrane review on interventions to promote patient utilization of CR. These were circulated to panel members, who were asked to rate each on a 7-point Likert scale in terms of scientific acceptability, actionability, and feasibility of assessment. A web call was convened to achieve consensus and confirm strength of the recommendations (based on GRADE). The draft underwent external review and public comment.

Results: The 3 drafted recommendations were that to increase enrolment, healthcare providers, particularly nurses (strong), should promote CR to patients face-to-face (strong), and that to increase adherence part of CR could be delivered remotely (weak). Ratings for the 3 recommendations were 5.96±0.68 (mean ± standard deviation), 5.33±1.12 and 5.64±1.08, respectively.

Conclusions: Interventions can significantly increase utilization of CR, and hence should be widely applied. We call upon cardiac care institutions to implement these strategies to augment CR utilization, and to ensure CR programs are adequately resourced to serve enrolling patients and support them to complete programs.

INTRODUCTION

Cardiovascular diseases (CVD) are among the leading burdens of disease and disability globally[160]. Cardiac rehabilitation (CR) is a model of secondary prevention to mitigate this burden. It is comprised of specific core components such as structured exercise, risk factor management, patient education and psychosocial counseling[15,17]. Utilization of CR is associated with 25% lower cardiovascular mortality, 18% less hospitalization, and improved quality of life[3], among other benefits.

Accordingly, CR is a recommendation in international CVD clinical practice guidelines. It is recommended for patients with acute coronary syndrome[161,93,5], following revascularization procedures[92,162], heart failure[88,163], and in specific populations such as women with CVD[164].

CR utilization is comprised of 4 elements (Figure 38)[29]. Patients must first be referred to CR by a healthcare provider. A Canadian Cardiovascular Society (CCS) – Canadian Association of Cardiovascular Prevention and Rehabilitation (CACPR) position statement regarding promoting CR referral is available elsewhere[165]. The patient-related aspects of CR utilization which are the focus of this policy position are three-fold: enrolment, adherence and completion (see definitions in Figure 38).

Although CR is strongly recommended after a cardiac event, its' use is suboptimal. CR utilization rates vary by jurisdiction, owing to multi-level factors[50], and hence global utilization rates are not established. A meta-analysis of CR enrolment rates reported an overall rate of 42.3 ± 18.7% (median 39.3%)[34], and of adherence of 66.5 ± 18.2% (median 72.5%) of prescribed sessions[37].

With regard to enrolment, the largest and most recent cohort where this was assessed using administrative data was in the United States, where enrolment rates of 16.3% were reported in Medicare beneficiaries post-MI or revascularization[32]. Again, the only population-based data of which we are aware with verified adherence stems from the United States, and showed that 40% of Medicare beneficiaries attended ≥30/36 and 13% of included participants attended <6 of 36 prescribed sessions[102]. The ASPIRE-2-PREVENT study in 19 randomly-selected hospitals in the United Kingdom reported that while 70% were "advised" to attend, 52% of all patients self-reported attending half of prescribed sessions[166] (which is only on average about 10)[167]; EUROASPIRE IV which assessed cardiac patients from 78 hospitals across 24 European countries revealed that while 51% were advised to attend CR, 41% of all patients self-reported attending half of prescribed sessions[168] (these are likely over-estimates due to socially-desirable responding). Representative population-based data on completion rates are available in the United Kingdom's CR registry; results suggest 77% of participants complete CR[169] (but caution is warranted in over-interpretation as sites may not enter data for patients who only attend an initial session). Utilization rates are even lower in non-high-income countries[99] where the epidemic of CVD is at its' worst.

Rationale and purpose

Given the benefits of CR, benchmarks for utilization have been previously established. Indeed, the purpose of this policy statement is to provide guidance on interventions that will ensure these benchmarks are met. Specifically, the aim is that 70% of indicated patients enroll in CR[28] (given that some patients may have legitimate contraindications; see exclusions below),

and that they participate in at least 12 sessions (although 36 sessions is associated with even better benefit)[87]. We ambitiously set a target of CR completion by 70% of enrollees.

The impact of achieving greater CR utilization are evident. For example, based on 2005 CR utilization rates post-MI in Ontario, Canada, it was projected that if CR use was increased to a 90% benchmark, there would be 135 deaths prevented or postponed annually, with a 1.3% (95% CI, 1.0-1.6) reduction in CVD mortality[170]. In a study conducted in the United States, the number of deaths that could be delayed or postponed if "perfect" guideline-based care (e.g., revascularization, optimal medical therapy, CR) was provided following acute cardiac events was estimated. Out of 10 treatments of known effectiveness for MI, other than acute revascularization, the greatest number of patient deaths could be prevented or postponed with optimal CR utilization. Similarly, optimal CR utilization was estimated to prevent or postpone the greatest number of deaths in patients with unstable angina and heart failure, compared with other guideline-based treatments[171].

With regard to adherence, the dose-response relationship between CR use and outcomes has been well-established; the more sessions patients attend, the better their outcomes[20,23]. A recent review examining CR dose showed adherence to a minimum of 12 comprehensive CR sessions was associated with 42% reductions in all-cause mortality, and adherence to 36 sessions was associated with 35% reductions in revascularization (percutaneous coronary intervention)[87]. Finally, it is also well-established that CR completers have lower death rates than non-completers[172].

Therefore, the objective of this policy position is to develop evidence-based recommendations on interventions to increase patient enrolment in, adherence to and completion of CR. The recommendations provided herein are directed to healthcare practitioners providing

inpatient acute cardiac care (e.g., nurses, physiotherapists, pharmacists), any referring providers (e.g., cardiologist, cardiac surgeon, internist, family physicians), and CR providers. CR promotion interventions should be initiated in the inpatient setting, and also delivered during CR.

It is hoped these recommendations will increase CR referral vicariously, but primarily patient utilization of CR, which in turn should improve patient outcomes. Indeed, implementation of the recommendations and tools could result in significant public health benefit, such as reduced cardiovascular mortality, morbidity and re-hospitalization, as well as optimize role resumption and quality of life, and decrease healthcare costs.

METHODS

Writing panel composition & stakeholder engagement

The writing panel was constituted based on the process of the CACPR Guidelines Executive Committee, and with input of the International Council of Cardiovascular Prevention and Rehabilitation Executive Committee (ICCPR). They recommended representatives of major CR societies (and where possible the corresponding authors of trials which were included in the Cochrane review[173] which forms the evidentiary basis for this policy statement were invited to represent their corresponding national CR association), while ensuring that the panel had diverse geographic representation, and included the healthcare provider types that would be implementing the recommendations (e.g., nurses, physiotherapists, among others). Panel co-chairs (CSP, SLG) were approved by both committees .

Patient partners (JS, PM) were solicited to serve as well as policy-makers (AA, NZ, SC, BR, SB, AG) to ensure implementability and uptake of the recommendations. The World Health

Organization and World Heart Federation were informed about the initiative, with a request for advice regarding implementation. A methodologist was secured (AG).

All members were required to disclose conflicts of interest, financial relationships or personal interests from 12 months before initiation of the writing effort that could impact their contributions to this statement at the time of statement initiation. These were collated and reviewed on a web call of the writing panel. Only 1 was raised, and was considered not to influence the writing of the statement (declaration available from corresponding author upon request). Finally, an external review panel was also populated, comprised of scientific and clinical experts, as well as representatives of relevant organizations and agencies.

Evidence collection, grading criteria and synthesis

This position statement is based on the results of the Cochrane systematic review update with meta-analysis on interventions to promote patient utilization of CR undertaken by the co-chairs (Figure 39)[173]. In brief, comprehensive literature searches were performed in July 2018 of 6 databases. The search strategy consisted of 4 elements: (1) Cardiovascular diseases, (2) Patient compliance (enrolment, adherence and completion outcomes), (3) Rehabilitation, (4) Motivational interventions and education.

Articles were included in the review if the following criteria were met: (i) included patients had a CR-qualifying condition, (ii) there was an intervention targeted to patients / groups, their partners / caregivers or other family members, or healthcare professionals with the specific aim of increasing patient utilization of phase 2 comprehensive CR, (iii) their design was randomized or quasi-randomized. The PICOs can be found there. Risk of bias in each included trial was assessed using Cochrane's tool[73]. Evidence for each outcome was evaluated according

to the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system[174].

Development process

The statement was developed in accordance with the Appraisal of Guidelines for Research and Evaluation (AGREE)-II[175], the Institute of Medicine's Trustworthiness Standards[176] and the RIGHT reporting guidelines[177]. Recommendations were initially developed by the panel co-chairs, with strength of recommendations based on GRADE[174]. The 3 drafted recommendations and exclusions were circulated to all other authors, who were asked to rate each on a 7-point Likert scale in terms of scientific acceptability, actionability, and feasibility of assessment[178] (higher scores more positive). Additionally, overall comments were requested. The ratings and comments from the authors were collated anonymously and shared with authors. It was established a priori that recommendations with mean overall ratings <5/7 would not be accepted as is[179]. A webcall was convened to discuss areas where consensus was lacking (as per standard deviations below, there was very high consensus), revisions based on comments provided, and to confirm strength of the recommendations. The senior author chaired the call to ensure all perspectives were voiced. The recommendations were revised accordingly.

The policy statement outline was developed by the co-chairs as well. Benefits and harms of the recommendations were considered, as well as costs and implementability. The first draft of the policy position was circulated to the writing panel for input concurrent with the recommendations. Feedback was incorporated by the co-chairs. A written record of feedback and corresponding edits has been archived. The revised policy statement was circulated to the writing

panel for discussion on the webcall, as well as to an independent external review panel of experts.

With integration of further input, it was submitted to the ICCPR Executive Committee and CACPR Guideline Executive for approval, and then to the major cardiac societies globally for endorsement consideration. The draft was also posted on ICCPR's website for a 45-day period to enable interested public stakeholders to provide input. Input received from associations and stakeholders was documented and considered, and integrated where appropriate. The writing panel will consider updating this position statement in accordance with updates to the corresponding Cochrane review, where changes to conclusions are found, new and superior interventions are identified or harms raised[173].

Cardiac rehabilitation utilization recommendations

As outlined below, effective strategies to increase patient utilization of CR were identified for each indicator / outcome[173]. Therefore, all inpatient and outpatient settings as applicable treating CR-indicated patients should be implementing these strategies to promote utilization. Recommendations are shown in Table 8. Overall ratings for the 3 recommendations were 5.96±0.68 (mean ± standard deviation), 5.33±1.12 and 5.64±1.08 on the 7-point scale respectively.

All authors of successful interventions (i.e., point estimate on right side of line of unity and confidence intervals did not cross) were contacted to request their materials used, along with their permission to post them open source for use by others. Received tools are available at http://sgrace.info.yorku.ca/tools-to-promote-cardiac-rehabilitation-utilization/.

Enrolment strategies

The meta-analysis demonstrated that enrolment interventions resulted in 27% greater utilization than was observed with usual care[173]. Subgroup analyses revealed interventions were most successful if they targeted nurses (sometimes with peers or allied healthcare providers; no trials intervened with physicians), to deliver them face-to-face, although these were only trends (i.e., $p>.05$ but $<.1$).

Successful interventions included: home visits and telephone calls[180,58] (including women-centered telephone calls[181]); coordination of the transfer of care between the hospital and general practice (where CR was provided)[60]; reducing the time to start CR (within 10 days)[62]; peer navigation (at the hospital bedside, then by phone or mail post-discharge; tools available online)[127]; text messaging[126]; and theoretically-based letters[63].

Adherence strategies

The meta-analysis demonstrated that adherence interventions resulted in significantly greater utilization than was observed with usual care[173]. Successful interventions included: a gender-tailored CR program[64]; a brief program[182] (there may be bias here in that it would be easier for patients to adhere to fewer sessions, and it is key that patients participate in a sufficient number of sessions to achieve the benefits); theoretically-based group[129] and individual (tool available online)[132] sessions; and exploitation of unsupervised settings[130,131]. Indeed, subgroup analyses revealed unsupervised delivery appears to be key, although this should be interpreted with caution as participation in a phone call is much easier for patients than attending a session on-site (i.e., low comparability of adherence operationalization).

Completion strategies

Again, the meta-analysis demonstrated that adherence interventions resulted 13% greater completion than is observed with usual care. Successful interventions included: theoretically-based patient education (tool available online)[132] and a smartphone-based intervention[126]. None of the subgroup analyses were significant.

Limitations

The limitations of the evidence review are reported elsewhere[173]. Chiefly, the interventions evaluated were varied and often multifaceted, resulting in high heterogeneity.

Implementation considerations

Exclusions

Endorsement of CR should be given to all indicated patients as per the guidelines cited in the introduction, however there are a few valid instances where CR is contraindicated (i.e., severe mental illness / cognitive disorders [e.g., schizophrenia, advanced dementia; but not depression], comorbid terminal illness / palliative care [e.g., non-curable cancer with expected life expectancy < 1 year], permanent resident in a long-term care facility). There can also be cardiac reasons that a patient may not be appropriate for the exercise portion of CR, but these patients should utilize all other core components (i.e., unstable angina, acute decompensated heart failure, cardiac infections, uncontrolled ventricular arrhythmias, aortic dissection, severe aortic stenosis, severe valvular regurgitation, acute thrombophlebitis, pulmonary or systemic embolism). These exclusions had an overall rating of 6.33/7. However, inability to ambulate (i.e.,

patient should receive non-exercise components; could use ergometer for upper extremity), lack of proficiency in the primary language in which the program is delivered (i.e., interpretation and translation services should be used), perceived lack of motivation (i.e., assuming patient would not be interested due to age or socioeconomic considerations) are not valid reasons to fail to promote CR utilization (overall rating 5.92/7).

Benefit-harm assessment

No studies considered the potential harms associated with the interventions. It was suggested to offer CR in unsupervised settings; given the safety (with appropriate screening and risk stratification) and comparable efficacy of CR in non-supervised settings has been well-established,[183] there should not be concern of harm. These exclusion criteria above should be considered when triaging patients to supervised or unsupervised settings; however most patients can safely be transitioned to unsupervised settings with standard risk assessment and following a few supervised sessions.

An observational study has suggested that offering too much reassurance and optimism to patients about their recovery during bedside discussions may be related to lower CR use[154]. In no trials were interventions associated with significantly lower utilization, however clearly consideration of messaging to patients is needed, balancing the need to reassure patients with the need to realistically convey what they can expect for their recovery. Ultimately, further research is needed on specific, optimal messaging to convey to patients to quell excessive anxiety yet promote CR utilization.

Overall, despite some null finding for all-cause mortality reductions in some recent CR meta-analyses[3,184], CR is well established to be associated with many benefits (see introduction),

and hence the potential harms associated with promoting utilization likely greatly outweigh any potential harms.

Value judgments and intentional vagueness

In terms of value judgments, again the authors perceive the benefits of CR are many, despite some recent null findings for the impact of CR in reducing all-cause mortality and revascularization[3,184]. Benefits for quality of life and re-hospitalization, among others, are not questioned in the literature.

Regarding intentional vagueness, its unknown whether specific tools used in the trials are generalizable to other settings, and hence specific tools or scripts have not been recommended. Replication of successful trial is needed, with an eye also to determining whether certain interventions are more effective and accepted in specific patient populations. Moreover, healthcare systems vary, in terms of inpatient length of stay, availability and reimbursement for CR services, as well as types of providers interacting with patients, which could all impact which interventions may be more feasible and effective.

With regard to the latter, it is unclear what impact type of provider promoting CR would have on patient utilization as there are no trials comparing provider types; most involved nurses. It is assumed this physician discussion with patients has not been tested in a trial due to greater perceived time constraints, but data from observational studies suggests physician encouragement in particular greatly impacts patient utilization[30,185]. The feasibility and impact of CR promotion by all types of healthcare providers that treat cardiac patients should be considered in future.

Role of patient preferences

Patients need to be aware of the existence of CR, and its' benefits. Intervention tools and scripts should be tailored to match patients' culture / language (i.e., translations, adaptations) and gender (i.e., consideration of women's unique needs)[186], among other sociodemographic characteristics (e.g., socioeconomic status, rurality), and delivered in a patient-centered manner (i.e., make sure patients have sufficient time to ask questions about CR, and that their emotions related to recovery from a life-threatening cardiac event are validated and addressed)[187]. It may be helpful if the provider or peer discussing CR with patients is of a similar sex or ethnocultural background so they can understand some of the barriers patients may raise. Indeed, interventions to increase utilization should also take into consideration patient's barriers (e.g., transportation, return-to-work, costs)[188]. Where possible, informal caregivers should be involved in CR discussions.

Patient's emotional and cognitive state should also be considered. Many patients experience anxiety due to worry of repeat events, and CR is a setting where patients are monitored by clinical staff and are supported to feel more comfortable in resuming activities of daily living. Moreover, approximately 20% of patients (even higher in heart failure) experience depression[189]. This can lead to low motivation, feelings of helplessness and psychomotor retardation – all factors which can impede CR participation but also be ameliorated by it. With regard to cognition, patients may have difficulty understanding and remembering discussions about CR if they have mild cognitive impairment (which may be temporarily caused by bypass surgery or cardiopulmonary resuscitation), have been sedated or are on medications which have cognitive effects, or dementia (depression can also impact cognition and decision-making).

Provision of hard copy resources such as CR program flyers or cards with website information for patients to take home, and again inclusion of informal caregivers in referral discussions, could mitigate these cognitive issues.

Once referred, patients should be given the choice to attend a centre-based or home-based CR program based on their needs and preferences (including geographic barriers), particularly considering the results of the subgroup analysis showing adherence interventions are most effective when at least part of it is offered in an unsupervised setting (e.g., eCR). Patients electing home-based programs still need support (from peers and providers) to promote adherence.

Cost implications

In the one study that examined cost[131], it was suggested that home-based CR may be more cost-effective than traditional supervised CR from a societal perspective. However, the Cochrane review in this area found equivalent costs of home versus supervised CR[183], suggesting there is not likely an economic benefit associated with offering CR in alternative settings. Considering CR is demonstrated to be cost-effective when examined in multiple health systems[190], even cost-saving considering avoidance of downstream healthcare utilization[183], that even a few additional CR sessions are associated with lower mortality[191] (and hence ability to contribute to society economically) and that CR participation is associated with return-to-work, clearly achievement of greater CR use overall has major benefits from a cost perspective.

No trial considered the cost of delivering a utilization intervention specifically. Given the nature of some of the interventions (e.g., healthcare providers making post-discharge home visits), these costs could be considerable, and should be quantified in future trials. These costs

would substantially impact implementation in the real-world. Some tested interventions however could be particularly low-cost (e.g., motivational letter by Wyer et al., 2001)[63], and hence could be scaled up across the cardiac population.

Cardiac rehabilitation capacity

There are too few CR spaces in all countries of the world to provide care to all indicated patients[192]. The lack of capacity can result in referral failure by physicians. Where patients are still referred as per guideline recommendations, the result is long wait times to start CR. It is known that longer waits are associated with lower utilization and poorer outcomes[193]. Given the rise in technological capability and penetrance, alternative models (i.e., delivered remotely) such as eCR should be exploited to augment capacity (including early access to online education materials or capability to interact with peers online while on the queue; e.g., cardiaccollege.ca). Integration of chronic disease management programs may also optimize resource utilization and hence augment capacity.

Potential organizational barriers to applying the recommendations

In addition to capacity constraints within CR programs, limited inpatient human resources (staff availability, time), lack of clarity on referral processes and which providers are discussing CR with patients, as well as lack of provider awareness regarding which patients are indicated and the nature of services delivered could hamper enrolment recommendation implementation. Moreover, many CR programs do not offer any, or have much, unsupervised CR capacity[194]. Some guidance is available on best practices in delivery of CR in unsupervised

settings through ICCPR's certification program (http://globalcardiacrehab.com/training-opportunities/certification/).

Low-resource settings

The trials on which these recommendations were based were all conducted in high-income countries, and hence application to low and middle-income countries is unknown. Cardiac patients in low-resource settings have less access to both acute care (where they would be encouraged to enroll) and CR. Healthcare providers are often even more stretched in their responsibilities, leaving less opportunity for communication with patients about CR. Provision of written materials may be more feasible, but patient health literacy must be considered; use of peers or community healthcare workers to promote CR may be more feasible. On a related note, the type of healthcare providers referring to and delivering CR often differs, and hence the type of provider encouraging patients to utilize CR may not necessarily be a nurse. CR capacity is even more limited. ICCPR has developed recommendations regarding CR reimbursement advocacy[195] and on how to deliver CR in unsupervised settings[196].

Implementation tools

The United States Center for Disease Control has its' Million Hearts initiative, and along with the American Association of Cardiovascular and Pulmonary Rehabilitation, are working to increase CR use from 20 to 70% nationally[197]. The recommendations in their road map are concordant with the recommendations herein. They have collated resources to help achieve their utilization targets in their CR Change Package (https://millionhearts.hhs.gov/tools-protocols/action-guides/cardiac-change-package/index.html).

Finally, the writing panel has developed implementation tools[82]. As outlined above, the available tools used in the successful trials have been collated online. It is hoped that their availability will facilitate implementation of these recommendations and further testing. Moreover, there are quality indicators / performance measures on CR enrolment[29,198,199] adherence[29,198,200] and completion[29,199–201]. Adoption can facilitate assessment of whether utilization at your institution meets recommended benchmarks. Financial incentives, such as pay-for-performance may enhance implementation.

To support implementation, an online course was developed by the co-chairs to inform inpatient cardiac healthcare providers about the important role they play in promoting patient utilization of CR over-and-above referral, and providing tangible recommendations on how to encourage patients to enroll at the bedside (http://learnonthego.ca/Courses/promoting_patient_participation_in_CR/story.html). It informs healthcare providers about the nature of CR and the benefits of participation, which patients are eligible for CR utilization (and also that there are few contraindications), key talking points (i.e., describe CR, its' benefits, the reason for patient referral [i.e., it is recommended just like their medicines for heart patients], that they highly encourage their patient fully participate, and the enrolment process; an accompanying point-of-care checklist is embedded for clinicians to download), as well as responses to some common barriers patients may raise (e.g., patients who live afar can access home-based programming; costs). It is applicable to all relevant provider types. It seeks to ensure providers' patients perceive they need CR, and that their providers strongly promote their participation. It is currently being evaluated, and if beneficial, will be disseminated more broadly.

Research directions

Some interventions tested in the included trials were developed in an evidence-based manner and are grounded in theory, and some are available open source for future testing. Trials are needed to determine whether successful interventions can be replicated (with fidelity), and to establish generalizability as well.

Research is needed to establish and test simple, brief, specific talking points for providers and text for patients to encourage enrolment. This would be more amenable to translation and cross-cultural adaptation, which could have much broader application and impact. The impact of type of provider promoting CR referral also requires more investigation (with consideration of feasibility and cost).

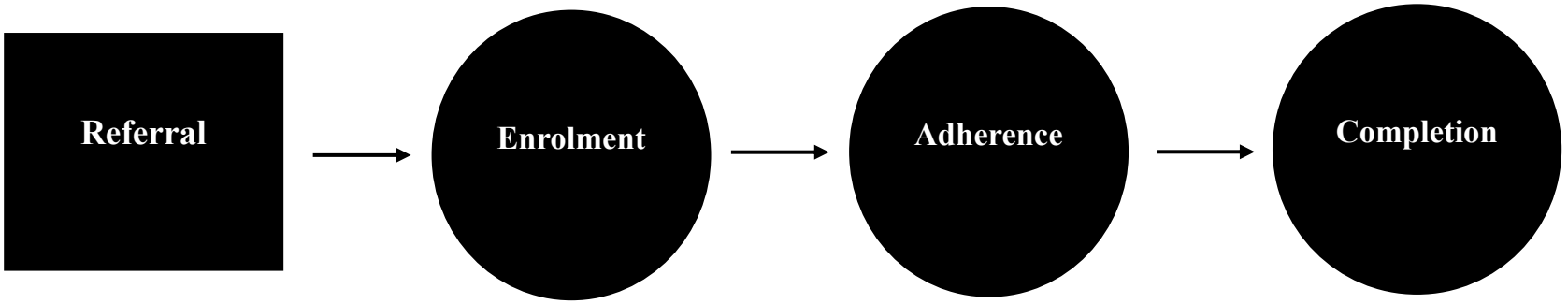
There were no significant subgroup analyses for completion, which leaves little direction on how to augment this indicator. Surprisingly, delivery of CR unsupervised was not significant as it was for adherence. More research is needed in this area to identify approaches to augment program completion.

Finally, while overall CR utilization is sub-optimal there remain vulnerable populations who are often under-represented in CR. This includes patients of low socio-economic status, ethnoculturally-diverse, and “complex” patients (e.g., comorbidities, smokers). More trials are needed to establish whether offering gender-tailored CR is associated with increased utilization in women. There were some interventions targeted to older patients, but whether successful interventions work in these other under-represented groups warrants investigation, and if not, tailored interventions need to be developed and tested.

CONCLUSIONS

CR utilization is sub-optimal, despite the established benefits. Interventions can significantly increase utilization of CR, and hence should be widely applied. Enrolment interventions should be delivered face-to-face by a nurse, and adherence is improved through remote delivery of CR. We call upon cardiac care institutions to implement these strategies to augment CR utilization, and to ensure CR programs are adequately resourced to serve enrolling patients and support them to complete programs.

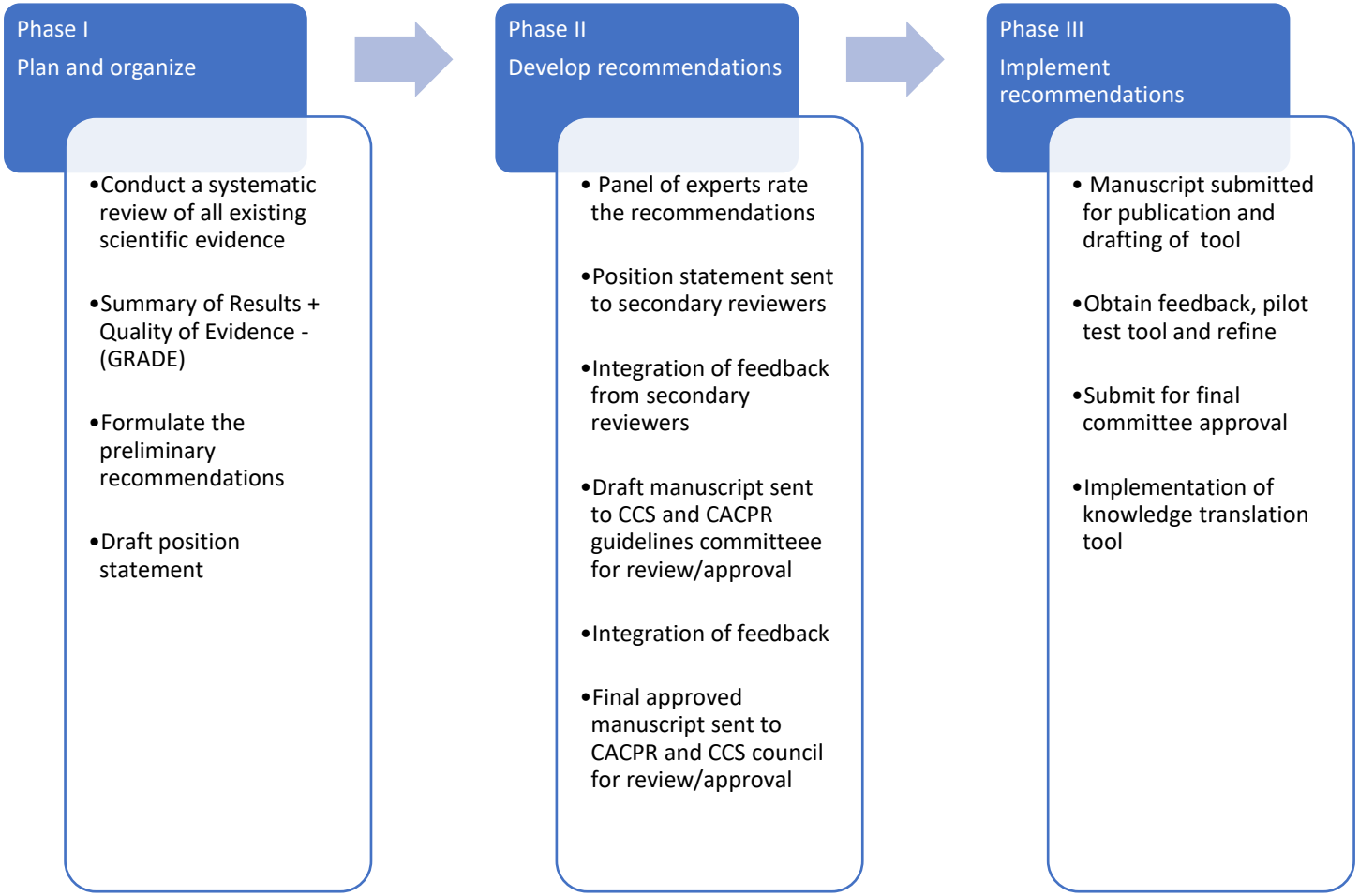
Figure 38. Definition of cardiac rehabilitation utilization indicators (Study 2)



CR = cardiac rehabilitation

Source: [29]

Figure 39. Position statement development and implementation process



CACPR, Canadian Association of Cardiovascular Prevention and Rehabilitation; CCS, Canadian Cardiovascular Society; GRADE, Grading of Recommendations, Assessment, Development and Evaluation

Table 8. Recommendations for cardiac rehabilitation utilization interventions with level of evidence and evidence sources (Study 2)

Recommendation	Quality of the Evidence (GRADE)	Strength of the Recommendations	Evidentiary Basis
1. Interventions to increase CR enrolment should target healthcare providers, particularly nurses, but also allied healthcare providers, to impact delivery to indicated[a] patients. Their messages promoting enrolment could be reinforced by physicians and peers.	⊕⊕⊖⊖ LOW	Strong	Carroll et al., 2007[180]; Cossette et al., 2012[58]; Jolly et al., 1999[60]; Scott et al., 2013[127]
2. Interventions to increase CR enrolment should be delivered face-to-face.	⊕⊕⊖⊖ LOW	Strong	Carroll et al., 2007[180]; Cossette et al., 2012[58]; Jolly et al., 1999[60]; Price et al., 2012[181]
3. To increase CR adherence, interventions should be delivered remotely, or some of the CR program should be delivered unsupervised	⊕⊕⊕⊖ MODERATE	Weak	Focht et al., 2004[129]; Hwang et al., 2017[130]; Kraal et al., 2014[131]

[a]acute coronary syndrome, revascularization, and heart failure, including women[161,93,5,92,162,88,163,164.]
CR=cardiac rehabilitation.

CHAPTER 4

Implementing recommendations for inpatient healthcare provider encouragement of cardiac rehabilitation participation: development and evaluation of an online course

CHAPTER 4: STUDY 3

CERTIFICATE OF AUTHENTIFICATION

Santiago de Araújo Pio, C., Gagliardi, A., Suskin, N., Ahmad, F. & Grace, S.L. (under review). Implementing recommendations for inpatient healthcare provider encouragement of cardiac rehabilitation participation: development and evaluation of an online course. Journal of Cardiovascular Nursing

Author	Contribution
Santiago de A. Pio, C.	- conception and design of the project (90%) - manuscript writing (40%) - drafting evaluation tools (questionnaires, checklists and knowledge questions) (60%) - recruitment of participants (70%) - conducted interviews, structured observation and collected data (100%) - analysis of data (100%)
Gagliardi, A., Suskin, N., Ahmad, F	- provided methodological input (50%) - clinician perspective on guideline implementation tool (100%) - critically revising the manuscript for important intellectual content (100%)
Grace, S.L.	- coordination of the project (100%) - recruitment of participants (30%) - input on evaluation tools (100%) - manuscript writing (60%) - assisting in interpretation of data (100%) - critically revising the manuscript for important intellectual content (100%) - providing final approval of the manuscript (100%)

Implementing Recommendations for Inpatient Healthcare Provider Encouragement of Cardiac Rehabilitation Participation: Development and Evaluation of an Online Course

ABSTRACT

Background: We recently published a policy statement with recommendations that inpatient healthcare providers should encourage cardiac patients to enroll in cardiac rehabilitation (CR) at the bedside, based on our Cochrane review update. This study describes the development and evaluation of guideline implementation tool.

Methods: A stepwise multiple-method study was conducted, based on best practices for guideline implementation initiatives. Inpatient cardiac healthcare providers (HCPs) were recruited between September 2018-May 2019 from two academic hospitals in Toronto, Canada. First, HCPs were observed (structured) during discharge discussions with patients to determine providers' needs. Results informed the selection and development of the tool by the multidisciplinary planning committee, namely an online course. The online course was pilot-tested with target users through a think-aloud protocol with subsequent semi-structured interviews, until saturation was achieved. These findings informed the course refinement before its final launch. Finally, to evaluate impact of the online course, HCPs were surveyed to test whether knowledge, attitudes, self-efficacy and practice changed from before watching the course, through to post-course and 1 month later.

Results: Seven nurses (71.4% female) were observed. Five (62.5%) initiated dialogue about CR, which lasted on average 12 seconds. Patients asked questions, which HCPs could not answer. The planning committee decided to develop an online course to reach inpatient cardiac HCPs, to educate them on how to encourage patients to participate in CR at the bedside. The course was

pilot-tested with 5 HCPs (60.0% nurse-practitioners). Revisions included providing evidence of CR benefits and clarification regarding pre-CR stress test screening. HCPs did not remember the key points to convey, so a downloadable handout was embedded for the point-of-care. The course was launched, with the surveys. Twenty-four HCPs (83.3% nurses) completed the pre-course survey, 21 (87.5%) post, and 9 (37.5%) 1 month later. CR knowledge increased from pre (mean=2.71±0.95/5) to post-course (mean=4.10±0.62; p≤.001), as did self-efficacy in answering patient CR questions (mean=2.29±0.95/5 pre and 3.67±0.58 post; p≤0.001). CR attitudes were significantly more positive post-course (mean=4.13±0.95/5 pre and 4.62±0.59 post; p≤0.05). With regard to practice, 8 (33.3%) HCPs reported providing patients CR handouts pre-course at least sometimes or more, and 6 (66.7%) 1 month later.

Conclusions: Preliminary results support broader dissemination, and hence a genericized version has been created. Continuing education credits have been secured to promote uptake. Further evaluation is warranted.

INTRODUCTION

Cardiovascular diseases (CVDs) are among the leading burdens of disease and disability worldwide[202,203]. In 2015, there were 422.7 million CVD cases globally[11], and these patients are at high risk of recurrent cardiac events and death[203]. Thus, secondary prevention is needed[14]. Cardiac Rehabilitation (CR) is a proven, cost-effective, outpatient model of care comprised of structured exercise training, patient education and counselling, as well as risk factor management[190,204]. The benefits of CR include 20% reductions in morbidity and CV mortality[205]. Despite the benefits, CR utilization is low[32,206–209]. One of the main reasons is lack of referral and encouragement by healthcare providers (HCP)[210].

The recent update of the Cochrane Collaboration review on interventions to promote CR utilization undertaken by our group[211] identified effective strategies. Findings included that CR enrolment is significantly greater when an intervention is delivered by a HCP, face-to-face. This could be undertaken most feasibly and affordably through communication at the bedside with CV inpatients prior to hospital discharge. A position statement to forward recommendations based on the findings was subsequently developed, and endorsed by 23 medical societies[212,213]. However, the development of a guideline or position statement is insufficient to change clinical practice and hence achieve greater patient utilization; therefore implementation tools are needed[83]. Indeed, a 2016 Cochrane review showed that implementation tools developed and disseminated with guidelines positively influence clinician behavior and patient outcomes[214]. Accordingly, implementation tools are recommended in standards for guideline development[175,176,215].

We undertook an environmental scan and consulted experts globally through the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR), and could not identify tools to support implementation of the recommendations (what is available is shown here: http://sgrace.info.yorku.ca/tools-to-promote-cardiac-rehabilitation-utilization/). Thus, a needs assessment was undertaken to discern the best type of tool(s) to promote patient-provider bedside discussions regarding CR; results were used to develop and then test a guideline implementation tool. The objectives of this paper were to describe the needs assessment, implementation tool development process, and evaluation of its' efficacy, with regard to learner knowledge, attitudes, self-efficacy, and practice. This tool could improve awareness and discussion about, as well as utilization of, CR, leading to greater secondary prevention of CVD.

METHODS

Team composition and stakeholder engagement

The team / planning committee was comprised of the co-chairs of the policy statement on interventions to increase CR utilization (CSAP, SLG)[212,213], as well as the methodologist with expertise in guideline implementation (AG). Clinicians who would be implementing the recommendations also served (NS, physician; CSAP, physiotherapist; AL, nurse-practitioner). A final team member served who has expertise in the various evaluative methods being applied (FA). We also solicited input from patient partners regarding whether the points to be conveyed at the bedside resonated with their information needs and preferences, was comprehensive, to ascertain if there were any omissions, and to ensure patient-centeredness. All 23 position

statement-endorsing associations were informed about the plan to develop guideline implementation tool(s), with a request for eventual input and dissemination facilitation.

Design and procedure

This was a multiple-method study, using a step-wise approach. We followed best practices for the development of guideline-implementation tools[82,216] and this led four-step inquiry: assess the needs for and barriers to implementation; determine the type of tool(s); develop it/them; and evaluate and disseminate. The process is summarized in Figure 40.

HCPs treating inpatients indicated for CR were recruited between September 2018 and May 2019 from two hospitals of an Academic Health Sciences Centre in Toronto, Canada (University Health Network; UHN), for the needs assessment (September-November 2018; structured observation), pilot test (November 2018-January 2019; interviews) and then evaluation (January-March 2019; prospective design). Ethics waiver was granted by the UHN Research Ethics Board as a quality improvement initiative.

There are different CR referral processes on the various cardiac units at the hospitals; for some it was an electronic systematic referral, on another referral is included on the paper-based discharge order set, and on others, there is no systematic process in place and hence physician referral is ad-hoc. Note that CR services are covered by government healthcare sources in Ontario.

Kirkpatrick's evaluation framework

Evaluation of the impact and effectiveness of an intervention is necessary so that the strengths and weaknesses can be identified, and improvements made. This tool was based on the first 2 levels of the 4 levels of the modified Kirkpatrick model[217]: Reaction (level I) involves

gaining direct feedback assessing a participant's reactions to the training. Learning (level II) can be described as the extent to which the attitudes of the participants change; knowledge increases or skills are broadened as a consequence of the training. Behavior (level III) is a measure of behaviour change in actions which takes place as a result of the training. Results (level IV) is the measure of the final organizational outcomes that occurred after participation in the training.

Needs assessment

First, literature regarding patient-provider discussions about CR was reviewed, including barriers[154,218]. Experts on patient-provider discussions regarding CR were consulted. Second, cardiac HCPs were observed (structured)[219] during inpatient-provider discussions regarding discharge, to learn what information was being conveyed regarding CR (and not), and what questions inpatients often have about CR, to ensure providers have the answers in the future (Appendix 1). To decrease the risk of reactivity, HCPs were informed we were interested in patient-provider communication regarding discharge instructions (CR was not mentioned until after the observation). The observer stood against a wall at some distance from the patient and HCP with a clipboard, and did not speak during the interaction.

After the observation, the observer debriefed with the HCP to get further detail regarding what information they felt they were lacking with regard to CR, and how they can be supported to discuss CR with patients. All observations and a discussion summary were recorded in writing immediately.

Implementation tool type and development

A review of guideline implementation tool types[220,221] was considered by the team. Results of the literature review and structured observation were discussed with the team, and expert opinion was also considered to decide on the type of tool(s). Development ensued in accordance with best practices[216]. Input from patient partners was sought, and incorporated.

Implementation tool pilot test: think aloud protocol and semi-structured interview

Once developed and hosted on UHN's eLearning centre, inpatient cardiac HCPs were recruited to view the online course (including the pre and post-course survey), in accordance with Level 1 of Kirkpatrick's model (reaction)[217]. It was pilot-tested with the intended audience using a think aloud protocol (TAP) with subsequent semi-structured interviews (i.e., retrospective questioning for triangulation), until saturation was achieved. This was undertaken in person at UHN. The purpose was to determine whether the drafted online course was applicable to target HCPs / realistic, met their information needs, was an acceptable length, to get input on graphics / visuals, ways to promote implementation of the ideas at the bedside, and how it could be revised to better meet their needs. Results informed refinement before launching the course.

The instructions for the TAP are shown in Appendix 2. The encounters were audio-recorded, with permission. They were transcribed verbatim, except to preserve anonymity. The senior investigator (SLG) attended the first few pilot tests for training purposes, and to finalize the drafted TAP protocol and semi-structured interview guide.

Implementation tool finalization and soft launch

Results of the pilot-test were used to finalize the course. It was launched for all users at UHN.

Formative evaluation: survey

HCPs were surveyed to test whether knowledge, attitudes, confidence/self-efficacy and practice / behaviour (e.g., if HCPs provided materials like pamphlet or handouts to patients about CR to take home) changed following completion of the course. These outcomes were chosen based on Kirkpatrick's model of training evaluation (level 2, learning)[217]. The questionnaire was administered online using Google forms: (1) before viewing the course; (2) immediately after viewing the course; and (3) 1 month later, via email. HCPs were emailed on several occasions with reminders to complete the 1-month post-course survey if they had not done so, to optimize response rate.

Participants: Recruitment and sample size

For each element of the project, participants consisted of acute cardiac care providers (e.g., nurses / nurse-practitioners, physicians, physiotherapists) on wards treating patients indicated for CR at UHN (e.g., short stay unit for percutaneous coronary intervention, cardiovascular surgery unit, general cardiology ward). There were no exclusion criteria.

Structured observation

To recruit for this initial needs assesment, all HCPs in the cardiology program were contacted through email by the clinical director, with a request to be observed during patient

interactions regarding discharge (CR was not mentioned). Unit nurse managers also identified some staff to approach. Attempt was made to observe HCPs on several cardiac wards. The plan was to observe interactions until no novel observations were made.

Observations with patients who were eligible for CR (see indications and exclusions in policy statement)[212,213] and who were soon to be discharged were undertaken. On the day of observation, HCPs approached patients in their circle of care without the observer present, to ask for their voluntary consent that an observer be present during the discharge discussion. Patients were informed that the observer was recording information about the HCP provision of discharge information, and only any questions or issues the patient raised would be notated (the rest of the observation pertained to the HCPs), and that their identity would remain anonymous. Willing patients provided verbal informed consent.

Think aloud protocol and semi-structured interview

After the tool was developed, eligible HCPs were contacted through email by the senior investigator (SLG) who holds an appointment as a senior scientist at UHN, with a request to preview the drafted online course and provide input. Recruitment was targeted to solicit feedback from several relevant disciplines, with emails sent to physicians, nurses and physiotherapists.

Survey

After the course revision and launch, eligible HCPs were contacted through email with a request to complete the online course, with the surveys. The emails were sent by the clinical director, and the senior investigator (SLG) later followed-up. The new course was also advertised in the monthly cardiology and cardiovascular surgery email blast. We also attended

team meetings on the cardiac wards to promote the course. The clinical director offered a pizza lunch to the cardiac ward with the highest completion rate.

Measures

Needs assessment: structured observation

The observer used a checklist (Appendix 1) to record observations and short descriptions of the interactions. The checklist was developed by CSP and SLG, and pilot-tested in 2 interactions. Some revisions were made. The senior author observed the first few observations and subsequent debriefings, to provide feedback for training purposes. The senior author independently completed the observation checklist, and discrepancies were discussed with CSP. This was repeated until no further discrepancies arose following an observation.

Pilot-test: Think aloud protocol and semi-structured interview

The TAP and interview guide are shown in Appendix 2. The TAP was performed using best practices[222]. The semi-structured interview guide was developed by CSP and SLG, and pilot-tested as outlined above.

Formative tool evaluation: Survey

The surveys administered at each point are shown in Appendix 3. They consisted of multiple choice and true-false questions, as well as items with a 5-point Likert type scale for responding. They assessed the basic characteristics of the HCP (e.g., profession), as well as their CR knowledge (e.g., how familiar HCPs were with what is offered and delivered to patients in CR) and attitudes, self-efficacy in discussing CR with inpatients(e.g., how confident HCPs were

addressing barriers patients raised regarding CR attendance), as well as their practices (e.g., giving CR program pamphlets to patients; Table 10).

Analyses

Observation

SPSS version 24.0 was used for quantitative analysis. Elements of the observation coded as present or absent were described using descriptive statistics. Analysis of the qualitative data involved bringing order and structure to the information recorded to inform development of the online course[223].

Think-aloud and interviews

The transcripts of the TAP and subsequent questioning[224] were segmented into sensible chunks or communication units, which were coded, all by the first author[225,226]. The coding of the TAP speech focused on thoughts reflecting ways in which the course could be improved (researcher inference; literal as much as possible), and of the interviews focused on validating interpretation of the think-aloud utterances, as well as extracting additional suggestions relating to how the course could be improved[227]. Initial coding by CSP was reviewed and discussed with the senior author, who was there for the initial interviews and reviewed the transcripts. Final coding / thematic content analysis was discussed between researchers to determine the course of action for revising the online course.

Survey

SPSS version 24.0 was used for analysis. All surveys were included. Descriptive statistics were used to describe the sample, as well as survey responses. Pre- and post-course survey responses were compared using paired t-tests or chi-square analyses as applicable (repeated measures analysis of variance was planned, but the sample size for the survey 1-month post-course was insufficient).

RESULTS

Needs assessment: structured field observation

Seven HCPs (all nurses) were observed (8 interactions); 5 (71.4%) were female. In most interactions, HCPs were rushing, to complete their "tasks". Family or informal caregivers were present for 5 (62.5%) interactions. Five (71.4%) HCPs knew whether their patient had been referred or was going to be referred.

Five (62.5%) HCPs initiated a dialogue about CR with a patient; however, the dialogue lasted an average of 12 seconds and lacked detailed information. No patients raised CR. In all interactions, CR was raised after the discharge instructions, at the end of the interaction.
In 1 (20.0%) of these 5 interactions, HCPs explained what CR is (e.g., consists of education and physical exercise), and none of these interactions was the information conveyed all accurate. In no interactions did HCPs explain why the patient was being referred, in 1 (20.0%) interaction the HCP mentioned some of the benefits of CR (i.e., "faster recovery", "get back on their feet"). In 2 (40.0%) interactions, the HCPs provided strong and explicit positive endorsement of CR, which

the observer rated as a mean of 4.5 / 5 (Appendix 1, item 8). In 1 (20.0%) interactions the HCP explained next steps to enroll (see below).

In only 1 (20.0%) interaction where CR was raised did the HCP invite questions about CR; and in 1 (20.0%) patients raised questions. Some patients asked about when the program would start and whether family members could attend, yet most HCPs did not know the answers. In 2 (40.0%) interactions barriers were raised, and 2 HCPs discussed ways to overcome them (e.g., HCP explained patient would be directed to CR program closest to home); in most cases, barriers were not sufficiently addressed. Overall, there was 2-way discussion about CR in 1 of the 8 encounters, and patients were provided a means to find out more information in 5, however this consisted of a brochure included among other brochures provided to patients at discharge, and the HCPs did not refer patients to it specifically.

Most commonly the HCPs gave the following 2 points when discussing CR: “The cardiac rehab program will call you in 2 weeks, and you will be referred to the program closest to home.” One HCP stated that the patient did not have to attend CR if they did not want to.
In an observation where CR was not initially raised, a senior nurse was training a new hire on how to go through the discharge summary with patients; the nurse lacked information about who should refer the patient to CR and stated: “If a patient asks about CR, just tell them that the family doctor will decide if they need to go, and they will be referred [to a site] close to home.”

During the observation the nurse trainee did not mention CR to the patient, and after debriefing with the researcher, the trainee felt compelled to go back and explain about CR to the patient, who asked many questions and seemed interested and likely to attend. In the other observation where it was not raised, the patient had an interpreter because he could not understand the English language; during the observation the HCP failed to mention CR to the

patient. When asked the reason during debriefing, the HCP responded: “I just forgot to mention CR.”

During the debriefing after the observations, most staff seemed aware of the importance of discussing CR participation with their patients. Overall, the observations revealed that HCPs are insufficiently discussing CR with their patients, wanted to know about who was eligible, and what were valid reasons patients should not go as well as what was not.

Implementation tool development

Based on the results from the structured observation, for policy statement recommendation implementation support, the team elected to develop training material for HCPs[220]. It was decided to develop an online course given how busy inpatient HCPs are, and that they complete online courses annually as a requirement for continuing professional education. The course was sponsored by the hospital’s CR program, and built by an eLearning and instructional design specialist from UHN in alignment with their best practices (Figure 40).

The training course was designed to inform inpatient cardiac care providers about: (1) what is cardiac rehab (and provide a corresponding patient handout); (2) the benefits of participation; (3) the importance of, and how to provide a positive endorsement regarding participation to patients; and (4) the importance of letting patients ask questions and discuss any barriers they may have. Input was also gathered from patient partners and other stakeholders (e.g., policy statement-endorsing societies)[212,213] on the main points to convey. With the patient partners, we considered how to convey risk associated with non-participation when stating CR benefits, and also considered evidence on how best to do this to encourage patient enrolment (e.g., gain frame – 25% less likely to die if go to CR)[228].

Pilot test: Think aloud protocol & semi-structured interviews

The TAP and interviews were conducted with female HCPs (2 nurse managers, 2 cardiology fellows [MD], and 1 nurse-practitioner), and averaged 22 minutes. Data collected from the TAP and interviews suggest that HCPs were satisfied with the content and length of the course. Themes are shown in Table 9 with examples and corresponding revisions made to the online course.

Revisions included providing evidence (i.e., forest plot and citation)[205] on the benefits of CR, as well as clarifying that pre-CR stress tests are performed under physician supervision and only after patient evaluation for readiness/safety. Additionally, HCPs did not remember the key points to convey to patients, so we developed and embedded a "key points" handout learners can print to use at the point-of-care (Figure 41).

Formative tool evaluation: knowledge, attitudes, self-efficacy, practice

Twenty-four HCPs (20 registered nurses [83.3%], 1 nurse-practitioner [4.2%], 1 physiotherapy assistant [4.2%], and 2 other HCPs [8.3%]; 23 female [95.8%]; mean age=36.4±11.6 years) viewed the online course and completed the surveys (retention shown in Table 10).

When asked pre-course whether their patients were generally referred to CR, 7 (29.2%) HCPs reported that patients are referred most of the time, 14 (58.3%) reported sometimes, and 3 (12.5%) indicated they are not referred. When asked whether they discuss CR with patients, 9 (37.5%) HCPs reported most of the time, 7 (29.2%) sometimes, and 8 (33.3%) never.

Survey responses are displayed in Table 10 by assessment point. As shown, viewing the online course resulted in significant increases in knowledge of what CR entails, having sufficient information to comprehensively discuss CR with patients, self-efficacy in addressing patient questions about CR and barriers, and attitudes toward discussing CR with patients. In terms of knowledge regarding types of patients that are eligible, pre-course HCPs were accurate for a mean of 3.33±0.87 of the 5 patient profiles, post-course HCPs were accurate for a mean of 4.33±0.86 of the 5 profiles (paired t=3.90 p=.001), and 1 month later for 3.78±0.66. Differences in practice could not be tested. Overall, for all items that could be tested, significant improvements were observed following viewing the course.

DISCUSSION

Guidelines and Position Statements can play an important role in health policy formation and healthcare delivery[79]. However, the development of guidelines with recommendations is insufficient to change practice; the recommendations must be implemented. A multitude of determinants influence if recommendations are implemented, at the guideline, clinician, patient, organization and healthcare system levels[82]. To our knowledge, there are no other implementation tools that are evidence-based which address how to increase CR utilization.

After an extensive literature review and needs assessment, a novel guideline implementation tool was developed to promote patient-provider bedside discussions regarding CR. The online course was pilot-tested with acute cardiac care providers. Subsequent evaluation revealed that viewing the course resulted increased CR knowledge, self-efficacy regarding discussing CR with patients, and more positive CR attitudes among HCPs. A point-of-care tool was also developed to support HCPs in having a fulsome discussion with patients at the bedside.

With these positive results, we went on to the implementation phase of the process (Figure 40). The online course has been genericized for a broader audience of inpatient cardiac care providers globally. This involved primarily removing institution-specific referral and CR program information. The course is available here: http://tiny.cc/PromotingCReLearning. We have applied for and secured continuing education credits for course completion (http://ccs.ca/en/professional-development/programs-and-events).

Thus, we are now seeking to inform our target audience of the availability of the online course, to promote wide learning. We are submitting the policy statement to guideline clearinghouses (e.g., ECRI), and including this as an implementation tool. We have asked the 23 position statement-endorsing societies and 35 ICCPR-member societies to disseminate the course to their members; they are doing this via email, websites and social media.

Directions for future research

As per the final step of the process in Figure 40, the genericized course require evaluation in a broader, larger sample. The evaluation should include investigation of change in practice (i.e., occurrence of discussions; i.e., Level 3 of Kirkpatrick's model- behavior)[217], the quality of CR discussions (e.g., structured observation pre and post-course viewing), and impact on CR utilization (i.e., Level 4 of Kirkpatrick's model - results)[217]. Many CR associations have utilization quality indicators which could be used to quantify impact[201]. Impact on HCP practices and quality of CR discussions over the longer-term post-course also should be assessed; there was insufficient data in the current study to even determine effect 1-month post-course, but what data are available suggest there is some decay over time without reinforcement.

As a requirement for being an accredited learning activity for continuing education credits, the genericized course does have a pre and post-course knowledge survey as well as evaluation / feedback on the course, which will be collated in future. We are also capturing country of origin of learners, and monitoring usage / uptake.

Other important avenues for future research include investigating inpatient CR information needs and preferences, such that a more standardized discussion could be specified for HCPs. This should then be evaluated, in terms of acceptability by patients, satisfaction, and ultimate CR utilization. The point-of-care tool could be revised based on patient input, and with evidence of impact on CR use. There truly is little evidence or guidance regarding the content of CR discussions, and based on our observations it seems some of the discussions that do occur may dissuade patients from attending or reduce their likelihood of enrolling. A question prompt tool for patients may also be helpful[229].

In the United States, the Agency for Healthcare Research and Quality (AHRQ) recently awarded a contract for implementation of systematic referral with a "liaison" discussion at the bedside in 100 hospitals (https://www.ahrq.gov/pcor/dissemination-of-pcor/cardiac-rehabilitation.html). Participating hospitals will be supported in a learning community, and will work on an aspect of implementation each month over the course of a year. This reinforcement may ensure sustained implementation (versus the decay we seem to have observed by 1-month post-course viewing). The online course may be useful in educating HCPs regarding bedside CR discussions. To be successful, it is helpful that the project ensures the referral itself, but also patients should be consulted about their needs and preferences for CR information at the bedside (see above), and inpatient units need to collaborate closely with the CR programs to which they refer to ensure they can accept additional patients (or increase their capacity if not). While

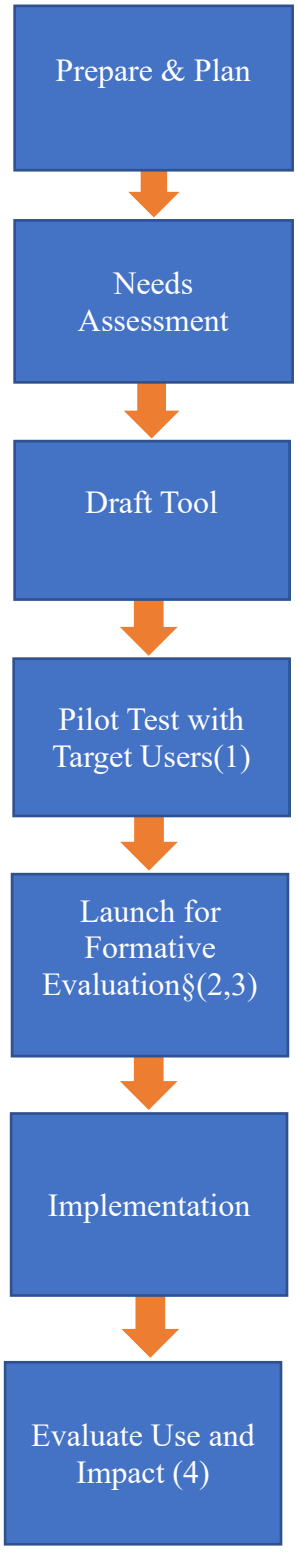
single-faceted and passive approaches can be effective[220], a systems approach, with tools for all aspects of the process (toolkit), is recommended to achieve CR enrolment targets[212,213].

Caution is warranted in interpreting these results. The study was single centre, and therefore it must be tested whether findings generalize, particularly to non-academic centers. At least the course was piloted on various types of cardiac wards. Second, unfortunately only nurses were willing to be observed for the needs assessment, but the team / planning committee did represent the types of HCPs targeted for the course. Third, during the structured observation, some HCPs might have altered their behavior due to an awareness that they were observed; however, they were not informed which aspects of their patient interaction was being evaluated. Given the low quality and quantity of the CR-specific content observed, this is likely not a significant concern. Finally, the sample size was small for the survey, and retention low.

CONCLUSION

The online course developed is the first available to our knowledge to educate HCPs regarding communication at the bedside to encourage patient utilization of CR, as per policy statement recommendations. The results of the evaluation suggest that HCPs who completed the online course had increased CR knowledge, self-efficacy and more positive attitudes. These preliminary results suggest broader dissemination and evaluation is warranted. It is hoped this tool can support inpatient cardiac care units to achieve 70% CR enrolment of their patients, so the high burden of CVD can be ameliorated.

Figure 40. Process for development, evaluation and dissemination of the guideline implementation tool for promoting patient utilization of cardiac rehabilitation (Study 3)



- Stakeholder engagement, including patient partners (conflict of interest declarations)
- Literature review of patient-provider discussions regarding CR, including barriers

- Structured field observations of cardiac inpatient discharge discussions, with debriefing
- Select guideline implementation tool type

- Development of course: format, content, length, graphics

- Think aloud protocol and semi-structured interviews
- Course revision

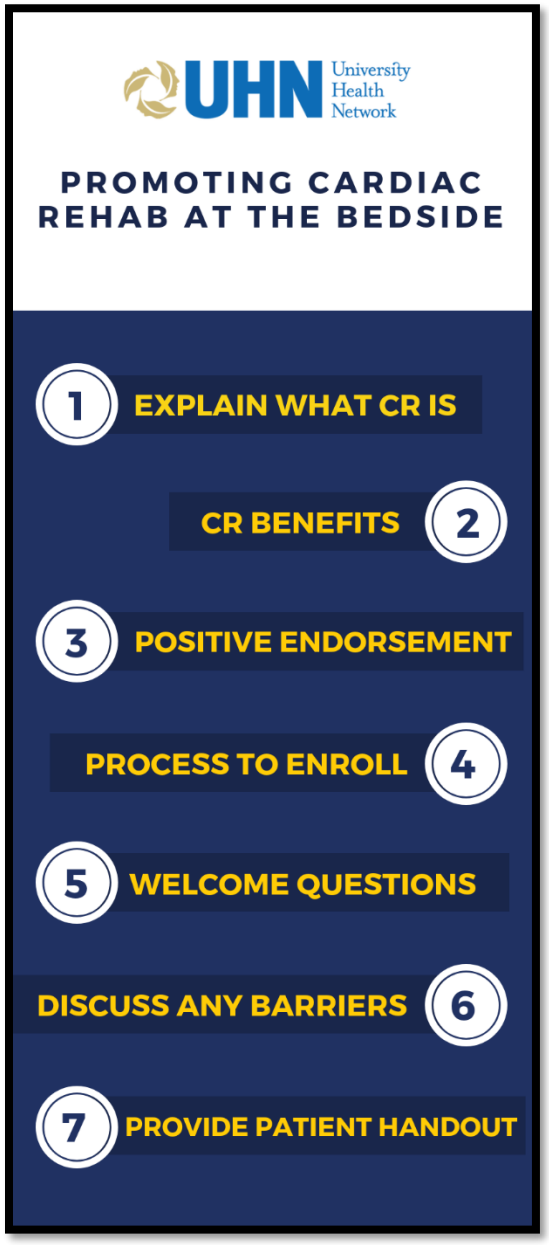
- Administration of pre-, post- and 1-month survey assessing impact on knowledge, self-efficacy and practice behavior
- Analysis

- Final editing; genericize for broader relevance
- Dissemination: 23 professional societies which endorsed policy statement (incl. newsletters, websites, social media); conference presentations; included in policy statement publication and appearances in guideline clearinghouses
- Incentives: credits for continuing professional development

- Currently capturing completion rates and country of learners;
- Also collating their feedback to inform future updates
- Evaluation of impact on CR utilization rates to be undertaken
- Evaluation of point-of-care tool needed

*steps based on cite[82,216,230–232], §outcomes selected based on cite[217], (Kirkpatrick's levels for training evaluation)[217]

Figure 41. Point-of-care tool: Key points for patient-provider discussion



CR=cardiac rehabilitation

Table 9. Selected coding from think-aloud protocol and subsequent interviews, with corresponding changes made to course (Study 3)

	Supporting segments / units (HCP #; *italicized text is excerpt from course on which HCP is reflecting*)	**Changes made to online course**
1: Details about CR delivery	*Over approximately 5 months, patients participate in sessions approximately 2 times per week covering guideline-based "core components", including: education, exercise and counselling.* "I think when providers and patients think of CR they often think they're just going to exercise. So, I liked that this breaks down that you're also going to get counseling and you're also going to get education on your condition. So that's good (HCP 3)." *Factors that should not impact referral to CR. Ambulation: These patients can still benefit from other components of CR, such as patient education, dietary counseling and stress management.* "So I think that's big because I know that I have a bias in my mind if a patient isn't able to exercise or isn't able to ambulate well. I often think of the benefit of rehab being minimal, but again, that's the bias of me thinking about it more as exercise as opposed to the other components. So, I like that (HCP 3)." *Recognizing patients who are indicated for cardiac rehab or who meet indications for Cardiac Rehab and understand how they are referred at UHN.* "Referral is a big part because even though we know CR exists, sometimes the referral process is a little bit like, well, how do we get patients there?... It's important we understand how that is done (HCP 3)."	-

	First language spoken- interpretation services are available. "I did not know that. I like that it shows it's really an all-inclusive process and that, as a rehab center we really try and accommodate people's different levels of abilities. So, I liked that (HCP 3)." *Patients will be triaged closest to home.* "So, the actual CR here, will figure out where they live and figure out where is the best rehab center for them? Okay, great (HCP 3)."	
2: Good and not good candidates for CR	*Poor Candidates for CR – serious mental illness.* "Serious mental illness… I don't really classify depression as serious (HCP1)." *Poor Candidates for CR section.* "I think most of these (not good candidates) should be obvious, but I think it's helpful to reiterate to us, as clinical practitioners, you don't want to send someone to rehab that it's going to be a dangerous process for them (HCP 3)."	**Added pop-up detail:** Serious mental illness, not including depression or anxiety
3: CR model	*What is CR? CR is an outpatient chronic disease management program, addressing all guideline recommendations for secondary prevention. Recommendations that you provide inpatients are reinforced.* "I think in this section about what CR is, the thing that comes up clinically a lot is how flexible is it? What times of day is it? Like if they're working, is it still an option or that sort of thing…These are the questions that I don't always have the answers to (HCP 2)." *Barrier #3: Patient is returning to work, lives out of town, or has no way to get to CR. Explain to the patient: Most CR programs*	**Added text:** Patients participate in sessions, in-person or on the phone, covering guideline-based "core components", including education, exercise and counseling. The number of sessions or calls varies by program (on average twice per week over 5 months) and are offered when convenient to the patient. Family members are welcome to attend as well.

	offer "home-based" models. "Home-based models? Is this where like they would give an exercise prescription so that they could come in less often? I think like that would play well into what we were talking about before too, with like how flexible it is versus, like do you have to come in two times a week and what hours of the day it is and that sort of thing... Because that does come up a lot, especially for younger patients (HCP 2)." "Oh, okay… Like over the internet or something like videos? I actually didn't know that education support can be provided over the phone. Very nice! (HCP 5)." "I didn't know that there was a home-based model from the get-go. I always thought they had to do the five months in rehab. Like in the physical place and then they could have their exercise prescription and be supported with their home-based? So, that's good to know (HCP 3)."	
Theme 4: Patient safety concerns	*How patients are referred at UHN.* "The biggest issue with my team is that the interventionalists are not highly convinced that patients should exercise and what length of time after their event they should start to exercise. Is every rehab supervised differently? Do they all have physicians? Who is responsible for the patient? (HCP 1)."	**Added phrase:** The patient will not undergo any exercise stress testing until they have been pre-screened and only under the supervision of a physician. Safety should not be a concern.
Theme 5: CR discussion – provider type	*Nurses are primarily responsible for initiating this discussion.* "I think that's great that nurses are responsible, but I also think that we as residents and physicians when discharging the patient should put a positive vote in for the program as well. We have evidence that shows patients are more likely to get engaged in things that physicians recommend. So, I think, we need to do a better job of promoting it as well (HCP 3)."	*Nurses sentence was removed, and sentence was added:* Often, providers are not sure who is going to discuss CR with patients, so no one does. Ideally, the physician should inform the team and patient that the referral is being made and nurses and allied HCP should reinforce this message by informing patients more fully about getting started.

	"Is it that we're saying that nurses should be the first point of contact in this discussion? Is it that they should start this discussion before a physician thinks that it is appropriate? (HCP 4)." "I think primarily nurses might not feel comfortable having that initial discussion with someone, let's say with heart failure, who doesn't fit the criteria or someone who's being admitted with some rhythm abnormalities. When is it safe to have that discussion? So, I almost feel like the first person should be the most responsible physician or clinician should have that initial conversation and nurses certainly can help (HCP 4)."	
Theme 6: CR participation barriers	*Key points for discussion: discuss how to overcome any raised barriers to entering the program* "I was always kind of under the impression that, you know, if I say to a patient that the CR will call them. If there are any barriers they can be addressed with the person over the phone. I don't know exactly what their capabilities are… I usually just encourage them to work at it with the CR. Maybe that's wrong what I've been doing. Because I don't think I'm very well equipped to overcome some of the barriers (HCP 2)." "A big barrier for patients is the language and cultural. You know in some cultures, women traveling long distances alone and things like that…or I don't think my mother would benefit from that because she doesn't really speak English that well or we can't get her there and that type of thing (HCP 4)." "I think the barriers are good barriers that were identified that our patients would have (HCP 5)."	
Theme 7: Request for additional information	*Benefits of CR include: Reducing cardiovascular death and re-hospitalization by 20%*	Figure with forest plot and manuscript citation was added, and the phrase "Reducing cardiovascular death and re-

	"It'd be nice to see some of this data. Reducing death and rehospitalization... It would be good to see some of the data (HCP 2)." "So, I think these last two points (Reducing cardiovascular death and re-hospitalization by 20% and significantly improving the patient's quality of life), um, I think a lot of healthcare providers will be impressed by the statistics. Does that mean it needs to go at the top?... I think maybe putting the point about and cardiovascular death and re-hospitalization higher up or maybe bolded. I think that could reinforce (HCP 3)."	hospitalization by 20%" was bolded.
Theme 8: eLearning module feedback	*Tools to support your discussion. Click the resources to the right for tools to support your discussion with the patient regarding CR.* "Oh, so this is like a pamphlet you can give to the patient to help them understand in writing what it is you've talked about? I like this because often I find when we give patients information at the bedside, they retain maybe 10 or 20 percent of it. I liked that they have option for something to take with them (HCP 3)." *Summary: You have reached the end of the Promoting Patient Participation in CR eLearning course.* "The course length is fine, it's good, it's not too much (HCP 1)." "The course was very good (HCP 1)." "Can I add that I really liked the length. Like I think that it's important that it's not too, too long. With the addition of a couple of slides maximum, like a little bit extra information that I think is high yield, I wouldn't change it very much (HCP 2)." "I thought it was concise. It wasn't too	

	verbose. I thought it was really well done (HCP 3)." "I think it was decent. It was good. I think appropriate. Ten to 15 minutes is fair. (HCP 4)." "The course length wasn't bad at all. It was pretty fast (HCP 5)."	
Theme 9: Course improvement	*What suggestions do you have for us to improve the course? How can we better support providers such as yourself to promote CR to your patients?* "I think the biggest thing is giving them (providers) tools. They need a lot of education about the importance of CR (HCP 5)." *"*I think more and more today people are doing or using those tools electronically. So, you know, like the little pocketbooks, the little, ACLS resuscitation cards that we use, and I just have those on my phone and I saved them as different files on my phone. But even if you had a pocket card, I think certainly the older generations would like that. And then if you don't want it in physical form and you only want in digital form, you could always just take a picture and have it as a file on your phone. So, I like that. (HCP 3)." "I think most people are very used to just having brochures in front of them and using that as a method for ensuring that they're getting everything that they're actually capturing everything. Something visual is important when we're talking about, especially if it's nurses, clinicians, that you just want to have that in front of you... To make sure you don't miss anything important (HCP 4)." *Do you think you will remember the points to discuss with patients? (referring to the Points to Discuss slide)*	A PDF tool with key points for discussion was created, which learners could download, and keep it in their phones.

	"Well, I guess it's not standing out to me from the presentation which are key points for discussion, I know what I'll usually tell patients, but I'm not sure… There's something about it that's not very memorable. Maybe create a handout… You know, what I think works well is things like little cards that people can attach to their badge… easy to carry around and keep on you or like in a lab coat. You know what I mean, like really small and portable. Or do a handout, but you know what, but a handout is always tricky. Like we'll just throw them out. You know, what I think works well is things like little cards that people can attach to their badge. I've gotten like stroke handouts and things like that are actually easy to carry around and keep on you. Or like in a lab coat. But if it's this size and it says like, you know, it's like 12 words, but it says like, what is CR, benefits? You know what I mean, like really small and portable. Then I think that it works better, but truly this slide was not memorable to me (HCP 2)."
	"What you could do instead of creating a handout it could be a pocket card that you give out to people? When you complete the course, you can enter your email address and then you email the recipient a PDF of that pocket card? (HCP 3)."

CR, cardiac rehabilitation; HCP, healthcare providers

Table 10. Survey responses by assessment point

	Assessment Point		
n (%) or mean ± Standard Deviation	Pre-Course 24 (100.0%)	Post-Course 21 (87.5%)	1 Month Post-Course 9 (37.5%)
Knowledge			
How familiar are you with what is offered and delivered to patients in CR?†	2.71±0.95	4.10±0.62***	3.78±0.67
Do you know how to ensure eligible/indicated cardiac patients in your care are referred to CR? (% yes)	9 (37.5%)	21 (100.0%)§	9 (100.0%)
Do you perceive you have all the information you need to comprehensively discuss CR at the bedside with your patients?¥	2.25±0.90	3.90±0.54***	2.78±0.97
Which of the following patients are not good candidates for CR?			
STEMI patient who is depressed	4 (16.7%)	3 (12.5%)	4 (44.4%)
Ventricular arrhythmia patient who is depressed°	12 (50.0%)	17 (81.0%)	8 (88.9%)
NSTEMI patient who lives outside of the city	5 (20.8%)	0 (0%)	0 (0.0%)
Patient with decompensated heart failure that lives outside of the city°	12 (50.0%)	15 (71.4%)	3 (33.3%)
Older NSTEMI patient without a spouse / informal caregiver to help with CR transportation	7 (29.2%)	1 (4.8%)	0 (0.0%)
Self-Efficacy			
How confident are you that you can address any barriers patients raise regarding CR attendance?ﺍ	2.42±0.88	3.76±0.54***	3.11±0.60
How confident are you in answering questions patients raise about attending CR? ﺍ	2.29±0.95	3.67±0.58***	3.44±0.88
Attitudes			
How important is it to you to provide information about CR to patients before they are discharged? ∞	4.13±0.95	4.62±0.59*	4.22±0.67
Practice			
Do/will you provide any materials to patients about CR to take home with them (e.g., pamphlet or handout with weblink)?		§	

Yes, most of the time	3 (12.5%)	21 (100.0%)□	5 (55.6%)
Sometimes	5 (20.8%)	-	1 (11.1%)
No	16 (66.7%)	-	3 (33.3%)

*denotes significant difference between pre and post-course scores tested via paired t-test or chi-square, as applicable: *p<.05, **p<.01, ***p<.001. Differences from the 1-month post-course scores were not tested due to the small sample size.
§differences from pre to post-course could not be tested as some cells had zero counts.
†scores range from 1 "I am not familiar with CR" to 5 "very familiar"
¥scores range from 1 "No" to 5 "Yes, I definitely have all the information I need to discuss CR"
ʌscores range from 1 "Not at all confident" to 5 "very confident"
∞ scores range from 1 "Not at all important" to 5 "very important"
°these patients would not be good candidates.
‡correct response.
□intentions only at this point.
CR: cardiac rehabilitation; STEMI: ST-elevation myocardial infarction; N-STEMI: Non ST-elevation myocardial infarction

APPENDICES

Appendix 1. Coding guide for structured observation of patient-provider interaction

Healthcare provider #: _____

Healthcare provider discipline: _____

Site and cardiac ward: _____

Patients day of hospital stay: _____ of _____ (if known)

Date and time: _____

	Element	Present/ Absent	Comments/observations (including any inaccurate information conveyed)
1	Initiated dialogue about Cardiac Rehabilitation (CR) referral with patient or family member		
2	Were any family members or informal caregivers present?		*If yes, type (if known) & #*
3	CR discussion embedded with other conversation? (for context)		*Make notes about what else was discussed with patient during encounter*
4	Explained what CR is		*Was it accurate?* *Summarize description here*
5	Explained why patient is being referred -i.e,. all patients with their heart condition are to be referred		
6	Mentioned some benefits of CR participation		*Specify which ones*
7	Provided strong and explicit positive endorsement of CR participation to patient or		

	family member		
8	Rate from 1 (negative) to 5 (very positive) how positive the endorsement seemed to you:		
9	Explained that the cardiac rehab program will call the patient at home a few days after their discharge -i.e., what are the steps to enroll		
10	Invite patient / family member questions about CR	☐ Yes ☐ No ☐ Not applicable because the patient/family raised questions spontaneously	*If yes, state what was asked* *Were they answered satisfactorily?* *Summarize responses*
11	Discussed how to overcome any raised barriers to entering a program	☐ Yes ☐ No ☐ Not applicable because no barriers raised	*Summarize.* *Were barriers addressed / mitigated?* *How?*
12	Was there 2-way discussion about CR		
13	Discussed or provided materials / tools about CR program (e.g., brochure, website)		*Specify what provided*
14	Did the healthcare provider know if the patient was referred or not?	☐ Yes, HCP knew pt was referred ☐ Yes, HCP knew pt wasn't referred or pt was not a good	*Did it seem the HCP knew how pts were referred and who did it?* *How? Conveyed to patient? Checked where / with who?*

		candidate ☐ No, HCP didn't know if pt referred	

Length of CR-specific discussion:_____ minutes: _____ seconds.

HCP=healthcare provider; pt=patient

NOTES:

a. Reflections on whether it seems patient is likely to attend:
_____
_____

Appendix 2. Think aloud protocol and semi-structured interview guide for tool / course pilot test

"Hello, my name is Carolina Santiago; I am a Physiotherapist and a PhD student at York University. My supervisor is Sherry Grace, a Scientist in Cardiac Rehabilitation at University Health Network (UHN).

We have developed an online course to support inpatient cardiac healthcare providers such as yourself to promote cardiac rehab use in your patients at the bedside. Your input will help us improve and finalize the course before we launch it. We want to make sure it is as useful for inpatient care providers as possible.

First of all, thank you for agreeing to help us. We will do 2 things: (1) you will watch the course and state your impressions as you go along, and (2) answer a few questions at the end. This should take around 20 minutes.

The course has been approved by UHN, and will be hosted though our learning management system MyLearning. If effective, we will circulate it more broadly.

As you watch the course, think out loud. By that, I mean while you are going through the slides, I want you to state what you're thinking as you go along. For instance, if the content is unclear or needed information is missing, please say those things out loud. Please be forthright so we get the most input we can to improve it.

We would like to test the course under real-world circumstance, so we will pretend that you are on your own. I will be making notes as you go along.

Is it okay if I record our discussion? I will be sure not to link your identity to the recording. We have an ethics waiver to evaluate this.

Do you have any questions before we begin?

RECORD.

Post-Viewing Questions for Semi-Structured Interview:
Thank you. Your insights have been very helpful. What questions do you have about the course or its' contents before I ask mine?

a) Was the content applicable to your reality on the cardiac ward? Were the recommendations for promoting patient use of cardiac rehab realistic?

b) Do you think you will be able to use and apply the information from the course to talk to your patients about CR? In what ways?

    - If not, why not? Is there different information you would need?

c) Did the 3 sections (i.e., what is CR, how referral is made, and what to say to patients) make sense and flow?

d) How was the length of the sections and duration of the course?

    - Is there any information you think that was not necessary to include?

    - Any information that was missing that would help you talk to your patients about cardiac rehab?

e) Any of the graphics not resonate with you? Things we should revise?

f) Was there a part of the course that made you feel more inclined to promote CR to your patients?

    - Was there anything in the course that dissuaded you from wanting to talk to your patients about CR?

g) Do you think you will remember the points to discuss with patients? How can we promote implementation of the recommendations with patients at the bedside?

h) What suggestions do you have for us to improve the course? How can we better support providers such as yourself to promote CR to your patients?

i) Lastly, is there anything else we should consider?

[After completion of post-course questions] OK, we're finished. Thank you so much for your time. Your input was invaluable.

Appendix 3. Online Course Surveys

Time 1: Pre-course

Please complete the following quiz. You will be asked complete an adapted version of this quiz at the end of the course, and again in one month.

1) What is your profession?
   - □ Physician
   - □ Nurse-practitioner
   - □ Nurse
   - □ Physiotherapist
   - □ Other allied healthcare provider
   - □ Other (please specify: _____)

2) How familiar are you with what is offered and delivered to patients in cardiac rehabilitation (CR)?
   - □ Very familiar
   - □ Quite familiar
   - □ Somewhat familiar
   - □ Scantly familiar
   - □ I am not familiar with CR

3) Are eligible/indicated cardiac patients in your care referred to CR?
   - □ Yes, most of the time
   - □ Sometimes
   - □ No

4) Do you know how to ensure eligible/indicated cardiac patients in your care are referred to CR?
   - □ Yes
   - □ No

5) Do you discuss CR participation with eligible/indicated patients at the bedside?
   - □ Yes, most of the time
   - □ Sometimes
   - □ No

6) Do you perceive you have all the information you need to comprehensively discuss CR at the bedside with your patients?

- □ Yes, I definitely have all the information I need to discuss CR
- □ Yes, I have the information I need
- □ I have most of the information I need
- □ I don't really have the information I need
- □ No

7) Do you provide any materials to patients about CR to take home with them (e.g., pamphlet or handout with weblink)?
   - □ Yes, most of the time
   - □ Sometimes
   - □ No

8) How important is it to you to provide information about CR to patients before they are discharged?
   - □ Not at all important
   - □ Slightly important
   - □ Somewhat important
   - □ Quite important
   - □ Very important

9) How confident are you that you can address any **barriers** patients raise regarding CR attendance?
   - □ Not at all confident
   - □ Not very confident
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

10) How confident are you in answering **questions** patients raise about attending CR?
   - □ Not at all confident
   - □ Not very confident
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

11) Which of the following patients are **not** good candidates for CR? (check all that apply)
   - □ STEMI patient who is depressed
   - □ Ventricular arrhythmia patient who is depressed
   - □ NSTEMI patient who lives outside of the city
   - □ Patient with decompensated heart failure that lives outside of the city

- □ Older NSTEMI patient without a spouse / informal caregiver to help with CR transportation

Time 2: Post-course

1) How familiar are you with what is offered and delivered to patients in cardiac rehabilitation (CR)?
   - □ Very familiar
   - □ Quite familiar
   - □ Somewhat familiar
   - □ Scantly familiar
   - □ I am not familiar with CR

2) Do you know how to ensure eligible/indicated cardiac patients in your care are referred to CR?
   - □ Yes
   - □ No

3) Will you provide materials to patients about CR to take home with them (e.g., pamphlet available through the weblink shown in the course)?
   - □ Yes, wherever possible
   - □ Sometimes
   - □ No

4) Do you perceive you have all the information you need to comprehensively discuss CR at the bedside with your patients?
   - □ Yes, I definitely have all the information I need to discuss CR
   - □ Yes, I have the information I need
   - □ I have most of the information I need
   - □ I don't really have the information I need
   - □ No

5) How important is it to you to provide information about CR to patients before they are discharged?
   - □ Not at all important
   - □ Slightly important
   - □ Somewhat important
   - □ Quite important
   - □ Very important

6) How confident are you that you can address any **barriers** patients raise regarding CR attendance?
   - □ Not at all confident
   - □ Not very confident
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

7) How confident are you in answering **questions** patients raise about attending CR?
   - □ Not at all confident
   - □ Not very confident
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

8) Which of the following patients are **not** good candidates for CR? (check all that apply)
   - □ STEMI patient who is depressed
   - □ Ventricular arrhythmia patient who is depressed
   - □ NSTEMI patient who lives outside of the city
   - □ Patient with decompensated heart failure that lives outside of the city
   - □ Older NSTEMI patient without a spouse / informal caregiver to help with CR transportation

Time 3: One month Post-course

1) How familiar are you with what is offered and delivered to patients in cardiac rehabilitation (CR)?
   - □ Very familiar
   - □ Quite familiar
   - □ Somewhat familiar
   - □ Scantly familiar
   - □ I am not familiar with CR

2) Are eligible/indicated cardiac patients in your care referred to CR?
   - □ Yes, most of the time
   - □ Sometimes
   - □ No

3) Do you know how to ensure eligible/indicated cardiac patients in your care are referred to CR?
   - □ Yes
   - □ No

4) Do you provide materials to patients about CR to take home with them (e.g., pamphlet)?
   - □ Yes, wherever possible
   - □ Sometimes
   - □ No

5) Do you perceive you have all the information you need to comprehensively discuss CR at the bedside with your patients?
   - □ Yes, I definitely have all the information I need to discuss CR
   - □ Yes, I have the information I need
   - □ I have most of the information I need
   - □ I don't really have the information I need
   - □ No

6) How important is it to you to provide information about CR to patients before they are discharged?
   - □ Not at all important
   - □ Slightly important
   - □ Somewhat important
   - □ Quite important
   - □ Very important

7) How confident are you in addressing any **barriers** patients raise regarding CR attendance?
   - □ Not at all confident
   - □ Not very confidentbar
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

8) How confident are you in answering **questions** patients raise about attending CR?
   - □ Not at all confident
   - □ Not very confident
   - □ Somewhat confident
   - □ Quite confident
   - □ Very confident

9) Which of the following patients are **not** good candidates for CR? (check all that apply)
   - □ STEMI patient who is depressed
   - □ Ventricular arrhythmia patient who is depressed

- □ NSTEMI patient who lives outside of the city
- □ Patient with decompensated heart failure that lives outside of the city
- □ Older NSTEMI patient without a spouse / informal caregiver to help with CR transportation

CHAPTER 5

General Discussion

Based on guidelines, all cardiac patients who are eligible for CR should be referred[2,4,5,6], however referral does not guarantee enrolment as access to CR programs encapsulates dimensions such as availability, affordability and accessibility[41,42,43]. Across the three interlinked studies presented in this dissertation, interventions to promote and increase CR utilization were explored and specific recommendations were presented to address these barriers.

In the first study findings from the Cochrane systematic review suggested that enrolment interventions may be more successful if delivered by nurses or other allied healthcare professionals (e.g. physiotherapists), in a face-to-face format. To increase CR adherence, unsupervised delivery appears to be a key facilitator to programme attendance, although further research is required to explore true effects for both outcomes.

In the second study, a position statement based on the evidence from the Cochrane review was developed by the and endorsed by 23 associations concerned with preventive cardiology. This evidence was translated into implementable recommendations to increase utilization of CR.

Finally, in the third study, based on Kirkpatrick's framework, an online course was developed to support implementation and inform inpatient cardiac healthcare providers about the important role they play in promoting patient utilization of CR. This course approached facilitators to CR utilization over-and-above referral, and provided tangible recommendations on how to encourage patients to enroll at the bedside.

Andersen's behavioral model application on CR utilization

Healthcare utilization is the point on the healthcare continuum where patients' needs intersect with the professional system. Various impediments can prevent or limit CR utilization.

Andersen's behavioral model proposes that healthcare utilization is influenced by a combination of factors[44]. This dissertation encompassed two of three predisposing factors from this model: predisposing and need factors.

Predisposing factors: As per our equity focus, Study 1 was able to identify studies that tested interventions designed to improve utilization among women and older participants, however we could not pool these data quantitatively. This was in line with the factors that influence one's predisposition to use healthcare resources mentioned in Chapter 1.

Enabling factors: In alignment with the findings and recommendations from this dissertation, providing patients with strong and supportive endorsement of CR by a healthcare provider at the bedside, may be critical in determining whether or not a patient will enroll in CR.

Need factors: Needs-related factors might the prime predictor of healthcare service utilization, in this instance it consists of the patients' perceived need for CR, considering that all patients referred to CR are shown benefit from such services (i.e., strength of HCP endorsement at the bedside as an important predictor of outpatient CR utilization). Previous published research is associated with increased healthcare utilization to those who receive health information about their condition and options[58,60,127].

Future Directions

Collectively, the studies included in this dissertation suggest that interventions can increase CR utilization, however further research is required to examine the underlying mechanisms in evidenced-based interventions designed to promote patient utilization of CR and to ensure that they can be replicated. Interventions should be standardized for testing in real-world practice with barriers to utilization in mind. Evaluation of single strategies will make it easier to identify the "active ingredients" of interventions. Moreover, the beneficial and adverse

effects of these interventions should be studied within the context of the costs and resources that they require.

Research is needed to establish and test simple, brief, specific talking points for providers to implement and patient educational material to encourage CR enrolment. This would be more amenable to translation and cross-cultural adaptation, which could have much broader application and impact. The impact of type of provider promoting CR referral also requires more investigation (with consideration of feasibility and cost). For the online course, the generic version should be evaluated in a broader, larger sample. The evaluation should include investigation of change in practice, the quality of CR discussions, and impact on CR utilization.

CLOSING REMARKS

In conclusion, despite clear importance of patient utilization of CR, to our knowledge, there are no evidence-based guidelines or position statements that provide specific recommendations to increase patient enrolment, adherence and completion of CR. The present dissertation is fundamental in the identification and knowledge transfer of effective interventions to promote patient utilization of CR programs. The recommendations and tool developed herein will potentially guide policy-makers, healthcare providers and cardiac patients towards greater utilization of CR and therefore, reduction of CVD risk.

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