Telehealth interventions for the secondary prevention of coronary heart disease: a systematic review and meta-analysis

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ABSTRACT

Background - Coronary heart disease (CHD) is a major cause of death worldwide. Cardiac rehabilitation (CR), an evidence-based CHD secondary prevention programme, remains underutilised. Telehealth may offer an innovative solution to overcome barriers to CR attendance. We aimed to determine whether contemporary telehealth interventions can provide effective secondary prevention as an alternative or adjunct care compared with CR and/or usual care for patients with CHD.

Methods - Relevant randomized controlled trials (RCTs) evaluating telehealth interventions in CHD patients with at least 3-months follow-up compared with CR and/or usual care were identified by searching electronic databases. We checked reference lists, relevant conference lists, grey literature, and keyword searching of the Internet. Main outcomes included all-cause mortality, rehospitalisation/cardiac events and modifiable risk factors. (PROSPERO registration number 77507).

Results - In total, 32 papers reporting 30 unique trials were identified. Telehealth were not significant associated with a lower all-cause mortality than CR and/or usual care [Risk ratio (RR)=0.60, 95% CI=0.86 to 1.24, P=0.42]. Telehealth were significantly associated with lower rehospitalisation or cardiac events (RR=0.56, 95% CI=0.39 to 0.81; p<0.0001) compared with non-intervention groups. There was a significantly lower weighted mean difference (WMD) at medium to long-term follow-up than comparison groups for total cholesterol [WMD=-0.26 mmol/l, 95% CI= -0.4 to -0.11, P <0.001], low-density lipoprotein [WMD= -0.28, 95% CI = -0.50 to -0.05, P=0.02], and smoking status [RR=0.77, 95%CI =0.59-0.99, P=0.04].

Conclusions - Telehealth interventions with a range of delivery modes could be offered to patients who cannot attend CR, or as an adjunct to CR for effective secondary prevention.

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INTRODUCTION

Cardiovascular disease (CVD), including coronary heart disease (CHD) and stroke, remains a leading cause of morbidity and mortality globally [1]. Management of CVD creates substantial economic burden, with estimated costs of Euro € 210 billion per year spent on CVD management in the European Union (EU)[2] . The majority of acute CHD admissions and events occur in those with previous CHD events[3], and this is where the greatest economic burden lies, with 68% of total costs spent on secondary care[4]. Therefore, to prevent CHD admissions and reduce costs, secondary prevention is of paramount importance and includes effective lifestyle risk factor reduction, and prescription of, and adherence to cardioprotective medications. Cardiac rehabilitation (CR) has evolved as the principal method of delivery of secondary prevention, and has been shown to reduce morbidity and mortality[5], to improve quality of life and to be cost-effective when compared to no CR [6]. However, CR is most frequently conducted in a facility-based, out-patient setting, in a time-limited model with individuals participating in group exercise sessions [7]. Although this model has been repeatedly demonstrated to be effective, CR uptake in the EU over the past 14 years has been consistently poor [8].

The reasons why people do not participate in facility-based CR are multi-faceted[9], and some may be addressed through service redesign, for example, delivery service out of working areas or moving facility to more convenient place[10]. Automatic referral systems have been shown to increase uptake[11]. But there are other reasons for non-participation, including: dislike of group programs, geographical distance from the service provider, inconvenient timing of programs, carer responsibilities, and potential financial penalties through taking time off to participate[9]. For these reasons, alternative models of service delivery have been proposed, which do not require the participant to attend a facility-based service[12]. Systematic reviews have demonstrated that intervention based in general practice[13], home-based interventions[14], and telehealth-based interventions[15] are all effective at reducing risk, improving quality of life, and have similar outcomes to the facility-based model.

In parallel to these findings, there have been rapid developments in technology, in particular with the introduction of smartphones, and ready accessibility of the Internet. Indeed, it is estimated that 85% of people in the EU have access to the Internet, with near 80% internet users used the internet via a mobile or smart phone[16]. Affordable technology is widespread, and it is predicted that use of technology in older adults is a major growth area[17]. This may offer opportunities to deliver secondary prevention via novel technologies, but also presents challenges due to the rapid technological advances at the same time as needing long duration of research studies[17].

We have previously demonstrated in a systematic review that telehealth is effective for delivery of secondary prevention of CHD [15] . We termed telehealth to include interventions delivered by the telephone, Internet, or video-conferencing. Eleven studies were included, all of which had to deliver more than 50% of the intervention remotely. However, this review was published in 2009, at which time only two studies had used the Internet for delivery, none used teleconferencing, text messaging was not identified as a delivery model, and mobile apps were not available. Since that time, text messaging has become commonplace, Internet use is ubiquitous, and mobile apps are evolving at unprecedented pace. Therefore, it is timely to update the previous systematic review, expanding our search terms to encompass these newer modalities. The aim of this review is to determine whether contemporary telehealth interventions can provide as an alternative or adjunct care compared with CR and/or usual care for patients with CHD.

METHODS

Literature search strategy

Relevant randomised controlled trials were identified by searching multiple databases from 1990 to 30 April 2018, including Current Controlled Trials register, Medline, The Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, and the Cochrane Library. We hand-searched bibliographies of relevant studies, systematic reviews, and abstract conference proceedings. We applied no language limits. The search terms and strategy were provided in the supplementary file (Table1) (PROSPERO registration number 77507).

Study selection

Two independent reviewers scanned titles and abstracts and identified potentially relevant articles (PG and LN). Studies were considered relevant if they were randomized controlled trials evaluating the effects of telehealth interventions on risk factor modification in patients with CHD with at least 3-months follow-up compared with CR and/or usual care. Telehealth interventions were defined as having greater than 50% of patient-provider contact for risk factor modification (addressing multiple risk factors) advice being delivered by the telephone, Internet, videoconferencing, text messaging, or mobile apps. Telehealth intervention could be delivered alone or as an adjunct to CR or usual care. The comparison may include CR or usual care. CR was referred to face-to face centre-based or community-based CR. Usual care was defined as any routine care for CHD excluding telehealth intervention.

Trials were excluded if they specifically targeted patients with heart failure, were primary prevention studies, or interventions, which were not delivered by a health-care professional. We also excluded studies where the intervention was directed at the health-care professional, and interventions such as the Heart Manual, where the major intervention component was determined to be paper based with supportive telephone calls.

Outcomes included coronary risk factor levels, all-cause mortality, cardiac mortality, and nonfatal acute-coronary events. Other outcomes considered were changes in quality of life, patient knowledge of risk factors for CHD, and economic measures and cost-effectiveness. When papers reported the same studies at different time-points, we reported the last follow-up time point that data was available for that study. We classified follow-up time into short-term (3-6 months), medium-term (6-12 months) and long-term (>12 months).

Study Quality and risk of bias

Methodological quality was assessed for all full text manuscripts included in the review. Risk of bias was evaluated (SK and KJ) according to the guideline of the Cochrane Handbook for Systematic Reviews of Intervention. Quality was assessed in terms of the risk of selection, performance bias, detection bias, attrition bias and reporting biases [18]. Risk was judged as high, low or unclear if data were uncertain or insufficient [19]. Our review followed PRISMA guidelines (supplementary appendix)[20].

Data extraction

All outcome data were extracted independently by PG and KJ. Any disagreement in interpretation of data and inclusion of studies between reviewers was resolved by consensus (LN and RG). Data were collected on a pre-developed data-extraction form and included patient demographics description of the telehealth intervention and clinical outcomes. We contacted the primary study authors when further information was required.

Data synthesis and analysis

The references and abstracts identified from the search were imported into Endnote X7 bibliographic software (Thomson Reuters, Philadelphia, Pennsylvania, USA) and all duplicates removed. Where papers about the same study reported outcomes at different follow up time points, data were analysed separately to ensure that the same case was not being counted twice. Data analyses were performed using Comprehensive Meta-Analysis Version 3 (https://www.meta-analysis.com/index.php). Heterogeneity was explored qualitatively by comparing study characteristics and assessed quantitatively using the I^2 statistic. I^2 values is categorised at 25% (low), 50% (moderate), and 75% (high). Random effects meta-analysis was used if heterogeneity was identified as indicated by a I^2 of >= 50% [21]. When statistical heterogeneity was high [21], subgroup analysis was performed to examine the differences between the types of telehealth intervention and comparators. Relative risk (RR) for dichotomous data and weighted mean difference

(WMD) for continuous data and their 95% confidence intervals (CIs) were calculated. Where synthesis was inappropriate, a narrative overview was undertaken. Hypothesis testing was set at the two-tailed 0.05 level.

RESULTS

Study selection and characteristics

A total of 14,292 studies were screened for possible inclusion and 80 full manuscripts were reviewed (Figure 1). In total, 32 papers reporting 30 unique trials (7283 unique patients) were ultimately included (Table 1). No trials evaluated videoconferencing. None of the trials were double blind and all reported adequate allocation concealment. The majority (about 77%) of study participants were men although no trials excluded women, and in one study sex was not reported. The mean age of participants was 61.72 (±4.26) years. In the majority of trials, patients were enrolled after an acute coronary syndrome (ACS) or revascularization. The time from the acute event to enrolment in the trial varied from 0–6 months. No trial reported any adverse events as a result of participation in the programs. Description of usual care in the comparison group were varied among the studies, including clinical visits, counselling on medication or secondary preventive behaviours by health professionals, or referring to hospital or community-based CR (Table 1).

Telehealth intervention was divided into two types: telehealth delivered alone as an alternative care, and telehealth as an adjunct care to CR and/or usual care (Table 1). Telehealth intervention as an alternative care was compared to face-to-face CR in two studies[22, 23], and compared to usual care in nine studies[24-32]. Telehealth intervention was delivered as an adjunct care to CR and/or usual care in nineteen trials (21 studies). Among these studies, telehealth intervention commenced after finishing CR in six trials (7 studies) [33-39]; telehealth as adjunct to usual care in five trials (six studies) [9, 40-44]; in another eight trials, participants in both intervention and control groups could participate in CR during the intervention[45-52], but numbers of those participating were only quantified in three trials, with participation varying from 21-51% in control groups and 18-53% in the intervention groups[45, 49, 50]. In two trials, participants were randomised to the intervention or to CR[23], in one trial to the intervention or to an ‘attention placebo[37] and in one trial to an e-diary[42].Exclusion criteria were similar between studies, with the key reason for exclusion being severe comorbid disease. Only one study specifically noted patients with heart failure being excluded[37].

Assessment of risk of bias

Quality assessment of risk of bias for the included studies was summarised in Figure 2. Overall, studies were categorised based on having low, high or unclear bias across various domains. In the selection bias category, most of trials were scored unclear for allocation concealment due to insufficient information. All trials were scored high risk for performance bias because neither participants nor the personnel could be blinded to allocation in all studies. About half of trails were high risk or unclear risk of detection bias for blinding outcome assessment. For the reporting bias, most of the trials reported all specified outcomes. However, for other source of bias, majority of the trials provided insufficient information to assess whether an important risk of bias exits.

Description of telehealth interventions

Of the 30 unique trials, six (n=1105) delivered interventions through a combination of telehealth options: two utilised Internet, mobile phones, and text messaging[46, 47]; two utilised a Smartphone app, and text messaging[40, 42]; two utilised Internet and a Smartphone app[27, 39]; and one utilised telephone calls, Smartphone app, and online monitoring[23] (Table 1). Eighteen studies (n= 5638) delivered an intervention predominantly by telephone[15, 22, 24, 26, 29-31, 33, 34, 36, 37, 41, 44, 45, 49, 50, 52, 53], and four studies (n=307) using the Internet[25, 28, 32, 48].Two studies (n=743) utilised text messaging alone[38, 51]. Of the two studies that reported longer term follow-up of a previously tested intervention, both utilised the telephone[9, 34]. Delivery and amount of contact varied substantially between studies. All trials included at least one face-to-face assessment. Interventions were delivered by nurses in five trials [24, 26, 28, 37, 46]; by nurses and dieticians in one trial[49]; by a nurse, dietician and exercise specialist in one trial[32]; by a nurse, dietician and physiotherapist in one trial[29] ; by a dietician in two trials[50, 51] ; and by a 'case manager' and dietician in one trial[48]. In six trials, health care professionals or 'health coaches', whose professional background was not described, delivered the intervention[27, 34, 36, 39, 44, 45]. In three trials it was unclear who had delivered the intervention[38, 42, 47]. In two trials, the intervention was delivered by a physiotherapist[30, 43], and in one trial each by a kinesiologist[31], a psychologist[25], a physiologist[33], a pharmacist[41], and a physician[40]. Contact time was not quantified in all trials and varied considerably in telephone-based interventions, ranging from 9 minutes to 9 hours. Telehealth intervention time varied from 6 weeks to 48 months. Total seven trials reported telehealth duration less than 3 months, twenty-one studies reported duration between 3 to 12 months, and two trials reported more than12 months.

Data synthesis

All-cause mortality

Of the 30 unique trials, 18 provided mortality data [15, 24, 26-29, 31, 32, 34, 36, 37, 40, 41, 45, 46, 48, 49, 52, 54], although no deaths occurred in four trials[29, 32, 41, 47, 48]. For analysis of mortality, the earlier report of the ELMI trial was used for meta-analysis[34], because in the longer term follow up 25 deaths were reported, but data were not separated for intervention and comparison groups[35]. The earlier CHOICE paper[43] was excluded from meta-analysis, as there were data available at the final follow up time of 4 years[9]. Total 14 trials were included in the meta-analysis. Telehealth as an alternative care compared with usual care was reported in 5 trials [24, 26-28, 31], telehealth as an adjunct care to CR and/or usual care was reported in 9 trials [9, 34, 36, 37, 40, 45, 49, 52, 54]. Meta-analysis of 14 trials reported no significant differences in all-cause mortality between telehealth intervention and comparison groups (fixed effect RR=0.60, 95% CI= 0.86 to 1.24; p=0. 42) in 6-48 months (Figure 3). Heterogeneity between studies was none (I^2= 0.0%).

Rehospitalisation/cardiac events

Eight trials reported rehospitalisation or cardiac events[26, 28, 29, 32, 36, 39, 46, 48]. In one trial, no events occurred[32]. Total seven trials were included in the meta-analyses, with three trials reporting telehealth as an alternative care compared with usual care[26, 28, 29]; and four trials as an adjunct care to CR and/or usual care[36, 39, 46, 48]. Meta-analyses showed telehealth intervention had a significant lower risk for rehospitalisation or cardiac events in 6 to 36 months compared with non-intervention groups (fixed effect RR=0.56, 95% CI=0.39 to 0.81; p<0.0001; I^2

=0.0%) (Figure 4). Subgroup analysis showed telehealth as an adjunct care was associated with significant lower risk for recurrent cardiac events (fixed effect RR=0.30, 95% CI= 0.14-0.64, P <0.001), but not significant in telehealth as an alternative care group.

Modifiable risk factors

Total cholesterol (TC) was reported in 19 trials[9, 15, 23, 24, 27, 31-34, 37, 39, 41, 47-52, 55]. One trial was excluded because it did not report standard deviation at follow-up and was unavailable from the authors[48]. Of the unique study data, the last follow-up time report was utilised, therefore two papers were excluded from meta-analyses because they were earlier reports of the same cohort[15, 34]. Telehealth as an alternative care was reported in five trials[23, 24, 27, 31, 32], as an adjunct care was reported in eleven trials[9, 33, 35, 37, 39, 41, 47, 49-52]. Meta-analysis of the 16 trials (3351 patients) reporting TC in the 3–48 months follow-up showed a significantly lower TC with telehealth intervention (random effect WMD=-0.26 mmol/l, 95% CI= -0.4 to -0.11, P <0.001; I^2=75.47%) (Figure 5). Subgroup analyses were performed to examine the differences between the type of telehealth and comparators (CR and/or usual care). The analyses showed telehealth as an adjunct care to CR and/or usual care was significantly associated with lower TC (WMD=-0.27 mmol/l, 95%CI -0.45 to -0.09, p<0.0001). Other subgroups analyses did not show significant differences but demonstrated a trend for the lower TC (Supplementary figure 1).

Low-density lipoprotein (LDL) cholesterol was reported in 14 trials[9, 23, 27, 32, 33, 39, 41, 47-52]. Two trials were excluded from meta-analysis as standard deviation was unavailable or data was reported in such a way that it could not be converted[48, 49]. Telehealth as an alternative care was reported in 3 trials[23, 27, 32], and as an adjunct care reported in 9 trials[9, 33, 35, 39, 41, 47, 51, 52, 54]. In the total 12 trials involving 2153 patients, LDL was significantly lower over 3–48 months follow-up for telehealth intervention compared with control group (random effect WMD= -0.28, 95% CI = -0.50 to -0.05, P=0.02; I^2 =77.32%) (Figure 6). Subgroup analyses showed telehealth as an alternative care was associated with significantly lower LDL compared with usual care group (-0.47, 95% CI= -0.72 to -0.23). Other subgroups analyses did not show significant differences but demonstrated a trend for the lower LDL (supplementary figure 2).

High-density lipoprotein (HDL) was reported in 14 trials[27, 31-33, 35, 37, 39, 41, 47, 49-52], involving 3376 patients, and was not significantly different at follow-up for telehealth intervention compared with control group (random effect WMD=0.007 mmol/l, 95% CI = -0.12 to 0.13, P=0.92). Subgroup analysis showed the similar results.

Triglycerides were reported in 11 trials[23, 27, 32, 33, 35, 39, 48-51]. It was not possible to extract data for meta-analysis in three trials[48-50]. In the eight trials including 1386 patients, there was no significant difference at follow-up for telehealth intervention compared with control group (random effect WMD=0.04 mmol/l, 95% CI = -0.32 to 0.40, P=0.82).

Seventeen trials reported systolic blood pressure (SBP)[23, 25, 27, 30-32, 39, 40, 42, 47-49, 51]. One trial was excluded from the meta-analysis because no standard deviation was available or mean difference was reported[48]. In the 16 studies included in meta-analysis (3657 participants), telehealth as alternative care was reported in 6 studies[23, 25, 27, 30-32], and as an adjunct care reported in 10 studies[9, 35, 37, 39, 40, 42, 47, 49, 51, 52]. Telehealth intervention was associated with lower SBP at all follow-up time points compared with non-intervention groups (random effect WMD=-0.12 mmHg, 95% CI = -0.26 to 0.02, P=0.10, I^2=72.65%), although the results were not statistically significant (Figure 7). Subgroups analysis showed the similar results (Supplementary figure 3).

Body mass index (BMI) was reported in 11 trials,[9, 31, 32, 35, 39, 40, 47-49, 51, 52] but SD was not available from one trial.[48] In the ten included studies (3110 participants) there was no difference in BMI in the intervention groups compared with control groups (WMD=0.09 kg/m^2, 95% CI = -0.21 to 0.39, P=0.54). Subgroups analyses showed the similar results.

Smoking status was reported in 10 trials (3295 participants)[9, 24, 26, 35, 37, 40, 44, 45, 47, 51] at 3 to 48 months follow-up. Telehealth as an alternative care to usual care was reported in two trials[24, 26], and telehealth as an adjunct to CR and/or usual care was reported in eight trials[9, 35, 37, 40, 44, 45, 47, 51]. There was a 23% reduction in the likelihood of smoking with telehealth interventions compared to control group (RR=0.77, 95%CI =0.59-0.99, P=0.04; I^2=67.9%) (Figure 8). However, subgroup analyses did not show any significant differences between subgroups (Supplementary figure 4).

There was marked variation in reporting and assessment measures for physical activity. In total, 21 trials (4905 patients) reported an outcome for physical activity[9, 22, 23, 26-34, 38, 39, 42, 44, 45, 48, 49, 51, 52], and, of those, two studies [28, 32] reported telehealth as an alternative care was associated with significant improvement in exercise capacity compared with usual care; six studies[9, 30, 45, 49, 51, 52] reported telehealth as adjunct care had significantly increased the level of physical activity compared with usual care and CR at all follow up time. Only six trials (1259) reported metabolic equivalent (MET) scores[22, 24, 32, 33, 35, 38].One trial was excluded from meta-analysis because no standard deviation was available[38]. There was no difference in MET scores between intervention and control (WMD=0.18, 95%CI -0.07 to 0.43, p=0.16).

An assessment of psychosocial state was included in 20 trials (5077 patients)[9, 23, 25-27, 29-31, 34, 36, 37, 39, 42, 45-49, 52]; although a range of self-report tools were used, including the short form-36[30, 31, 46], the EQ-5D[23, 36, 42, 46], the Cardiac Depression score[9, 49], the Hospital Anxiety Depression Scale (HADs)[36], the Centre for Epidemiologic Studies Depression scale[37], the Health Related Quality of Life scale[26, 27, 29, 45], the Dartmouth Quality of Life index[39], the MacNew scale[25], the Illness Perception Questionnaire[44],and other depression-related scales[47, 48, 52]. In ten trials, psychosocial status improved with telehealth intervention as alternative care compared with usual care in two trials [23, 29], and as an adjunct care in eight trials [26, 30, 36, 39, 42, 44, 45, 49]. In the remainder of the studies there was no difference in psychosocial status, although an increase in anxiety, measured by the HADs was noted in two trials[26, 47].

Nutritional status was reported in 11 trials [23, 25, 28, 29, 31, 34, 39, 44, 45, 47, 52], with five reporting significant improvements in the intervention groups[31, 39, 44, 45, 52], and the remainder reporting no difference between groups.

Only three trials reported costs of delivery[30, 46, 48], with all three stating that the interventions cost less to deliver than usual care, but only two including a full cost-effectiveness evaluation[46, 48]. One trial showed telehealth intervention appeared to be cost-effective compared to usual care for increasing walking among CHD patients[46]. The other study reported the net cost saving of $965 per person with an estimated return of 213% on telehealth intervention [48].

DISCUSSION

This updated systematic review of telehealth interventions for secondary prevention of CHD provides a comprehensive summary of remote delivery methods as an alternative or an adjunct to traditional face-to-face cardiac rehabilitation programmes and/or usual care. Our results indicate there was not significant differences in mortality between telehealth interventions compared with either usual care or cardiac rehabilitation. However, telehealth delivered alone or combined with traditional care and/or CR showed favourable changes in secondary prevention for patients with CHD, including reduction in recurrent cardiac events, TC, LDL and smoking status. Specifically, telehealth combined CR and/or usual care may achieve significant beneficial results in medium and long-term duration. Lasting duration of cardiovascular risk factor improvements remains key to preventing recurrent events and is a critical consideration when recommending models of intervention. The programme characteristics varied substantially in both content and duration, yet all trials demonstrated at least some benefits across a range of risk factors. Perhaps of most interest, is that despite the remote delivery nature of the interventions, the majority made substantial improvements in physical activity, a core component of facility-based cardiac rehabilitation interventions.

This review contributes to the body of evidence of the benefits of telehealth interventions for secondary prevention. Telehealth interventions have been demonstrated to show at least equivalent outcomes to outpatient-based cardiac rehabilitation for mortality, exercise, cholesterol, blood pressure and smoking [56]. This review identifies that when telehealth interventions are used as either an adjunct or alternative to cardiac rehabilitation and/or usual, there are improved outcomes in recurrent cardiac events, TC, LDL, and smoking. Similar benefits have been reported in reviews of telehealth interventions for secondary prevention of cardiovascular disease[57], but only included mobile intervention in this review.

The telehealth interventions included in this review were more diverse than previously since the last review[15]. For instance, the rapid growth in the use of the Internet, mobile and Smartphone in the last decade has enabled new techniques such as automated text messages and mobile applications[16, 17]. Also the Internet and mobile phone are almost ubiquitous, enabling cardiac rehabilitation patients' exposure, confidence and interest in using these methods[58]. An important feature of these techniques is freedom from limitations of real-time, repetitive contact by health professionals, instead, software-enabled systems may be used for delivery, either alone or in combination with other methods[42, 51]. In contrast to more traditional telehealth methods based on phone-calls, these strategies have the potential to reduce timing-related barriers to patient's participation,[59] as well as staff time and therefore the costs of programs[60]. Importantly, the addition of trials testing these new delivery methods did not reduce the beneficial effects on risk factor reduction reported in earlier reviews[15, 56], rather adding to the potential modalities and technologies available to deliver the interventions. For instance, in this review automated text message delivery[51] was as effective as real-time telephone contact with a nurse [24] in reducing smoking.

Substantial improvements in patient outcomes and risk factor profiles have occurred from the systematic use of cardio-protective medications and other treatments since the previous review. For instance, between 1990 and 2010 prescriptions for statins in acute coronary syndrome patients increased by 37.4% to 47.5% ($p = 0.005$) resulting in dramatic improvements in risk factors such as TC[61]. More recent secondary prevention interventions would be expected to have lesser effects against this background of reduced risk profile and this is evident in the current review. Differences achieved through telehealth interventions for TC and SBP were not as substantial as the 2009 review (WMD TC -0.26 mmol/l vs -0.37 mmol/l; SBP -0.12 mmHg vs -4.69 mmHg)[15].

Increasing diversity in interventions and delivery methods were evident in the review, which can complicate review processes, particularly for distinguishing the specific active processes necessary for an effective telehealth intervention[62]. Much as the CONSORT statement has enabled more precise reporting and comparison in systematic reviews, a taxonomy of secondary preventive interventions, would enable comparison between and across specific intervention components[63]. When the effect of individual elements have been distinguished and evaluated, more useful conclusions can be reached[64]. For example, when the components of telephone support and remote monitoring in post-discharge heart failure programs have been analysed separately, telemonitoring was identified as effective in reducing mortality and heart failure related hospitalisations, whereas telephone support was only effective in reducing heart failure related hospitalisations.

While some of our findings achieve statistical significance, they may not have reached clinical significance for the individual patient. Despite this we did observe significant reduction in hospitalisation which has both clinical and statistical significance. The most effective frequency and duration of telehealth interventions also remains to be determined. Many trials did not report this detail of frequency of telehealth intervention, despite the implications for patient outcomes including psychosocial distress and on intervention costs. While there was some evidence in the review to support cost reduction from telehealth interventions, only three of the 30 included trials collected this information, and comparison was not made to either phone-call only or outpatient-based delivery[30, 46, 48]. Furthermore, in-person and group-based delivery offered by outpatient-based cardiac rehabilitation may have psychosocial benefits for patients that could not be adequately assessed in this review due to the use of diverse measures and/or failure to measure these outcomes. In some studies, participants could attend CR in both intervention and comparison groups. However, the numbers of participants attending CR were only quantified in 3 trials with participating rates varying from 21-51% in usual care and 18-63% in the telehealth intervention plus usual care. Therefore, it is difficult to demonstrate incremental benefits when telehealth as an adjunct care. However, we did note additional benefits to telehealth used as an adjunct to CR in terms of reduced hospital readmission and TC.

Further limitations of the included trials were primarily sample-related and included small sample size as well as diverse and sometimes restrictive inclusion/exclusion criteria. Many studies had less than 100 participants. While participants all had coronary heart disease, some studies restricted age or only included graduates of cardiac rehabilitation, adding another set of restrictions. There is lack of consensus on evaluating and defining the duration of follow-up time after health intervention for CHD patients. There is a need to standardise these terminologies for future reporting

CONCLUSIONS

Despite a significant variation in the reviewed telehealth interventions, they offer substantial benefits for the secondary prevention of cardiovascular disease in comparison to usual care and are equivalent to centre-based cardiac rehabilitation. Specifically, telehealth combined usual care and/or CR may bring additional benefits to the patients with CHD, particularly in reduction of recurrent cardiac events and TC at medium to long term duration. Telehealth interventions with a range of delivery modes could be offered to patients who cannot attend CR, or as an adjunct to CR. Telehealth interventions were associated with less death over-time, although it was not statistically significant; therefore, to achieve statistical power, larger trials with higher quality would be required. This review did demonstrate that telehealth interventions have the potential to improve cardiovascular risk factors - the major objective of facility-based CR. Telehealth interventions mostly delivered by the phone and/or Internet could enhance access to a formal secondary prevention by patients unable to attend centre-based CR and could therefore narrow the current evidence and practice gap in this specific area.

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