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RESEARCH

Telemonitoring or structured telephone support programmes for patients with chronic heart failure: systematic review and meta-analysis

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ABSTRACT

Objective To determine whether remote monitoring (structured telephone support or telemonitoring) without regular clinic or home visits improves outcomes for patients with chronic heart failure.

Data sources 15 electronic databases, hand searches of previous studies, and contact with authors and experts.

Data extraction Two investigators independently screened the results.

Review methods Published randomised controlled trials comparing remote monitoring programmes with usual care in patients with chronic heart failure managed within the community.

Results 14 randomised controlled trials (4264 patients) of remote monitoring met the inclusion criteria: four evaluated telemonitoring, nine evaluated structured telephone support, and one evaluated both. Remote monitoring programmes reduced the rates of admission to hospital for chronic heart failure by 21% (95% confidence interval 11% to 31%) and all cause mortality by 20% (8% to 31%); of the six trials evaluating health related quality of life three reported significant benefits with remote monitoring, and of the four studies examining healthcare costs with structured telephone support three reported reduced cost and one no effect.

Conclusion Programmes for chronic heart failure that include remote monitoring have a positive effect on clinical outcomes in community dwelling patients with chronic heart failure.

INTRODUCTION

Chronic heart failure is a common diagnosis, carries a poor prognosis, and affected patients are major consumers of healthcare resources.[1] As the prevalence of chronic heart failure is increasing this situation will deteriorate unless new management strategies are developed.[2] The effectiveness of multidisciplinary non-pharmacological approaches for improving outcomes in patients with chronic heart failure has been well established in over 30 randomised trials.[3-7] As most of these trials have tested multifaceted approaches, however, it has been difficult to identify the incremental benefits of the components of each intervention.[6] Nevertheless, it is clear that within most populations access to these programmes is limited as a result of barriers related to funding or geography.[8] As a result interest is increasing in remote monitoring models for delivering care, which incorporate information communication technology either as telemonitoring (transfer of physiological data such as blood pressure, weight, electrocardiographic details, and oxygen saturation through telephone or digital cable from home to healthcare provider) or as regular structured telephone contacts between patients and healthcare providers, which may or may not include the transfer of physiological data.[6]

Earlier reviews of multidisciplinary programmes for chronic heart failure have been unable to make definitive conclusions about the value of remote monitoring strategies given the paucity of relevant studies and patient numbers at the time of these analyses.[5 6] However, several studies with relatively large numbers of patients have since been published, permitting a more detailed analysis. We evaluated the effect of remote monitoring strategies in patients with chronic heart failure and whether the effect differed by the type of technology used for the communication of information.

METHODS

We updated two earlier systematic reviews that dealt with telemonitoring[5 6] by searching 15 electronic databases using search methods recommended by the Cochrane Heart Review Group.[9] All randomised trials evaluating remote monitoring programmes published between 1 January 2002 and 6 May 2006 were included. Databases searched included the Cochrane library and the Cochrane CENTRAL register of controlled trials, Medline (1 January 2002 to 6 May 2006), Embase, CINAHL (1 January 2002 to 6 May 2006), AMED, ISI web of knowledge, HSTAT, Ingenta, Zectoc, LILACS, and science citation index expanded (to search forward to detect studies citing the original reviews), DARE, national research register, Psych Info, and web of science. We also hand searched the reference lists in 21 published systematic reviews of disease management programmes in chronic heart failure,[3-7 10-26] 149 review articles on telephone support

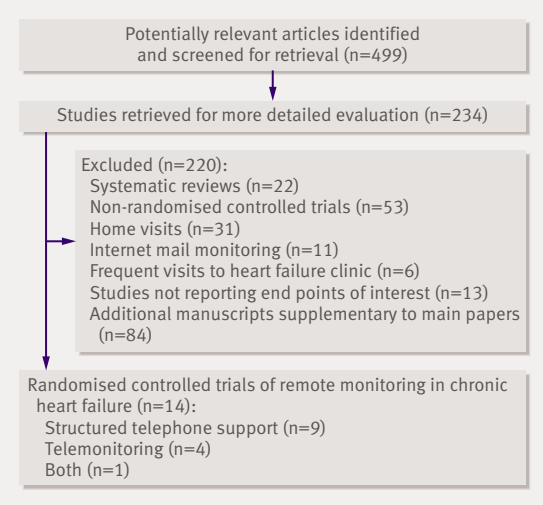

Fig 1 | **Flow of study selection**

programmes in chronic disease, and those studies identified in our electronic searches that met the inclusion criteria. Unpublished conference proceedings were reviewed and published abstracts were included if the authors replied to our request and sufficient details and outcomes of studies were retrieved. Finally, we communicated with the principal investigators of the identified trials and with national and international experts in the specialty to identify any studies we had potentially missed. We did not restrict study inclusion by language but did limit our review to only randomised controlled trials.

We applied the highly sensitive search strategy from the Cochrane Collaboration.[9] Keywords for searches of the database included heart failure (exp), cardiac failure (exp), telemedicine (exp), telecare (exp), telemonitoring (exp), teleconsultation (exp), teleconference (exp), telecommunications (exp), case management (exp), comprehensive health care (exp), disease management (exp), health services research (exp), home care services (exp), clinical protocols (exp), patient care planning (exp), nurse led clinics and special clinics (exp), randomised controlled trial (s), controlled clinical trial, random allocation, double blind method, single blind method, clinical trial(s), research design, comparative study, follow-up study, and prospective study.

Search strategies were written for each database and double checked by the second reviewer, under the direction and supervision of a medical librarian.

Types of interventions

Remote monitoring programmes started by a health professional (medical, nursing, social work, pharmacists) for patients with chronic heart failure living at home were eligible for inclusion if the monitoring was carried out at least once in the first month after hospital discharge, was targeted towards the patient (that is, the patient had to be the person on the telephone), was structured (as opposed to offering telephone follow-up on an "as needed" basis), and was to be delivered as the only aftercare intervention without home visits or more than usual clinic follow-up. We excluded studies in which the remote monitoring was intended primarily to deal with the problems of care givers rather than of patients. We a priori classified programmes as being structured telephone support if they consisted of standardised telephone contact of patients with chronic heart failure and relied on reporting of symptoms alone, or telemonitoring if they consisted of telephone contact for eliciting symptoms and transmission of physiological data.

Our primary outcomes were all cause mortality, all cause rate of admission to hospital (proportion of patients readmitted to hospital at least once during follow-up), and rate of admission to hospital as a result of chronic heart failure (proportion of patients readmitted to hospital at least once during follow-up). Our secondary outcomes were health related quality of life, cost, and acceptability.

Validity assessment and data abstraction

Two investigators (RAC, SCI) independently reviewed the results of the searches for study inclusion and extracted data. We excluded any studies in which additional home or clinic visits (more than usual care) were offered to patients in the intervention or control arms. Study quality (particularly method), randomisation, and intervention, were judged using accepted criteria and compared with the review protocol.[9] Disagreements between the two reviewers were resolved by a third reviewer (SS, FAMcA, or JGFC). Data abstraction was carried out independently and blinded by RAC and SCI, with FAMcA checking extracted data. Overall the inter-rater reliability on key inclusion criteria (randomisation and intervention) was strong (κ score 0.73, 95% confidence interval 0.54 to 0.92).[27]

Study characteristics and data synthesis

Owing to the expected differences in patient populations, programme characteristics, and length of follow-up, we carried out our primary analyses using the DerSimonian and Laird random effects model. Analyses were carried out using RevMan 4.2 (Nordic Cochrane Centre).[9] As the outcomes of interest were relatively common we calculated risk ratios and 95% confidence intervals. The risk difference (difference between observed proportion of the event in the treatment and usual care groups[9]) was calculated by subtracting the risk of the event in the usual care group from that of the treatment group. These data are presented with 95% confidence intervals.

We carried out intention to treat analyses—that is, all patients and their outcomes were analysed in the groups to which they were allocated, regardless of whether they received the treatment. We examined for statistical heterogeneity in each outcome of interest using Cochran's Q test and I^2 statistic. Secondary outcomes (expected to be reported less often) were described and tabulated.

RESULTS

Overall 234 of 499 citations were reviewed in detail. Of these, 14[w1-w14] randomised controlled trials (4264 patients) were eligible for inclusion (fig 1). One trial was three armed[w1]; to avoid double counting of the control patients the results for the control arm were shared between the two comparisons for the pooled analysis of all remote monitoring programmes, but all patients in the control arms were counted in each of the sub-analyses (telephone support *v* usual care, telemonitoring *v* usual care). Four trials evaluated telemonitoring, [w11-w14] nine evaluated structured telephone support,[w2-w10] and one[w1] evaluated both. Ninety five per cent of the included trials were captured by the Medline search, 2% from CINAHL, and 3% from hand searching and contact with experts.

The length of follow-up of these trials ranged from three to 16 months, the mean ages of participants ranged from 57 to 75 years, and all trials enrolled patients with symptoms (New York Heart Association classification range II-IV, left ventricular ejection fraction <40%). Structured telephone support programmes included monitoring of symptoms, medicine management, and education and counselling on lifestyle. All the telemonitoring programmes included transfer of daily data on weight, pulse, blood pressure, and electrocardiographic findings.

The quality of the studies was evaluated using Cochrane recommendations.[9] The 14 included studies were rated as adequate, reporting 61% of the recommended quality variables. Six (42%) described concealment and some level of blinding of patient or outcome assessors, and seven (50%) reported completeness of follow-up (table 1).

Quantitative data synthesis

All cause mortality

All 14 trials reported all cause mortality (15 comparisons, 581 deaths, fig 2) and the pooled estimates showed a statistically significant 20% reduction (95% confidence interval 8% to 31%) with remote monitoring programmes. The benefits were greater with telemonitoring (risk ratio 0.62, 0.45 to 0.85, P=0.003, based on 127 deaths in 807 patients) than with structured telephone support (0.85, 0.72 to 1.01, P=0.06, based on 482 deaths in 3542 patients), although this difference did not

Table 2 | Effect of remote monitoring on chronic heart failure related quality of life, cost, and acceptability to patients

Study	End point (months)	Health related quality of life* and depression	Effect on cost or patient	Cost of intervention	Acceptability of intervention to patients
Cleland et al 2005 (TEN-HMS study)[w1]	400 days†	—	—	—	4.1% of patients refused to accept technology in their homes, 2.9% of patients asked for equipment to be removed, and 1.8% discontinued recording. Overall patient acceptance was 91.2%. 96% of patients were well satisfied with the system and 97% found the telemonitoring devices easy to use
Barth 2001[w4]	2	Increase in scores on MLHFQ (P≤0.0005)	—	$23.60/patient	—
Riegel et al 2002[w5]	6	—	46% reduction in inpatient costs (P=0.04)	$443/patient	Patient satisfaction was significantly higher among people assigned to intervention group compared with usual care group (P=0.01)
Laramee et al 2003[w6]	3	—	$2482/patient (average) reduction	$228.52/patient (average)	—
Tsuyuki et al 2004[w8]	6	—	$C2531/patient reduction	—	—
GESICA investigators 2005[w9] (DIAL trial)	16 (mean)	Increase in scores on MLHFQ, mean total score, intervention *v* control 30.6 *v* 35.0, mean difference 4.4, 95% CI 1.8 to 6.9, P=0.001	—	—	—
Riegal et al 2006[w10]	6	MLHFQ (NS), EQ-5D (NS), depression by PHQ-9 (NS)	No effect on cost of care for heart failure or all cause acute care cost	—	—
De Lusignan et al 2001[w11]	12	GHQ, CCHFSQ (NS)	—	—	Video link over standard telephone lines was not found to be useful by participants
Goldberg et al 2003 (WHARF trial)[w12]	6	MLHFQ (P=0.22), SF-12 (physical score P=0.15, mental score P=0.73), HDS (P=0.57)	—	—	—
Woodend et al 2003[w13]	3	Increase in scores on MLHFQ (P=0.025)	—	—	Very highly satisfied

$1.00 (£0.51; €0.75). $C1.00 (£0.44; €0.65).
Blank cells indicate no data available for variables. NS=not significant or no P value reported; MLHFQ=Minnesota living with heart failure questionnaire; PHQ-9=patient health questionnaire 9 item; GHQ=general health questionnaire; CHFSQ=chronic heart failure symptomatology questionnaire; HDS=health distress score.
*Variance between baseline and study end point, details provided as included in study.
†Patient acceptability measured at 400 days.

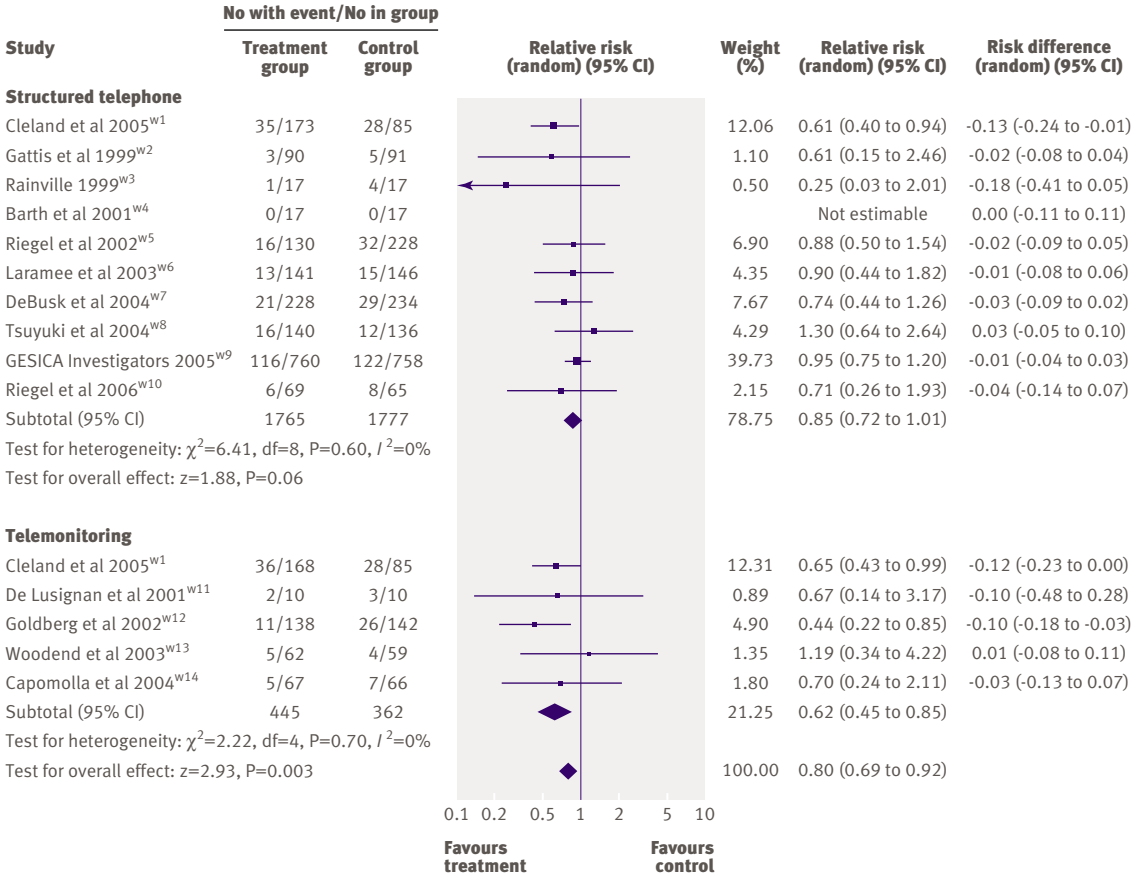

Fig 2 | **Effect of remote monitoring on all cause mortality**

achieve significance (P=0.18) using the adjusted indirect comparison method described by Song et al.[28] Mortality data from these 14 trials showed little heterogeneity (P=0.56, I^2=0%).

All cause admission to hospital

Of the eight trials (nine comparisons) that reported rates of all cause admission to hospital (fig 3), none reported a statistically significant result. Even the pooled estimates did not show a significant benefit on this end point with remote monitoring programmes (0.95, 0.89 to 1.02).

Hospital admissions as a result of chronic heart failure

Nine trials (10 comparisons) reported rates of admission to hospital as a result of chronic heart failure, and although only one reported a statistically significant benefit, all trials showed similar relative reductions (P for heterogeneity 0.76, I^2=0%) and the pooled results showed a reduction of 21% (11% to 31%) with remote monitoring programmes (fig 4). Although no appreciable difference was found between the relative reductions seen with telemonitoring and telephone support programmes, evidence from randomised trials was insufficient to conclusively state that telemonitoring programmes reduce admissions to hospital since only one of these trials reported this outcome.

Quality of life, cost, adherence, and patient acceptability

Only six trials examined the effect of the intervention on health related quality of life (table 2). Of these trials, three reported a significant and substantial improvement in quality of life between the intervention and control groups at the end of follow-up. The effect of the intervention on healthcare costs was reported in only four of these trials (all of structured telephone support); however, three of the four trials reported lower healthcare costs for patients randomised to the intervention (table 2). The cost of the intervention was infrequently reported and variation existed between programmes (table 2). None of the trials on telemonitoring reported the cost of the intervention or its effect on healthcare costs. Acceptability of the intervention to the patient was under-reported, with only four trials reporting this outcome (table 2). Three of these trials reported that the intervention was acceptable to patients, with patients from one trial of telemonitoring considering the video link not useful.[w11]

An analysis of publication bias using funnel plots showed an unlikely possibility of bias within studies showing a reduction in mortality after remote monitoring.

DISCUSSION

This systematic review found that remote monitoring programmes for patients with chronic heart failure

living in the community reduced admissions to hospital and all cause mortality by nearly one fifth while improving health related quality of life, but had no significant effect on all cause admission to hospital. Although few studies have examined economic outcomes, the three studies on structured telephone support suggested that the interventions were economically cost effective Thus, this systematic review builds on earlier ones[5 6] of multidisciplinary interventions for chronic heart failure by tackling key issues and uncertainties relating to the specific effect of telephone based programmes. This review is particularly important as remote monitoring programmes provide a potentially feasible option for dealing with the expanding population of patients with chronic heart failure that cannot be accommodated within existing multidisciplinary chronic heart failure clinics owing to constraints caused by geography or resources.

The significant effect of structured telephone support on the risk of admissions to hospital for chronic heart failure (risk differences ranged between 2% and 35%) can be attributed in part to the triage of patients by telemonitoring nurse at the first sign of clinical deterioration, and the consequent immediate intervention of a primary care doctor.[w5 w14] Similarly, all trials on telemonitoring in this review involved daily transmission of vital signs, weight, and symptoms at various time points to healthcare providers, thus potentially leading to earlier detection and management of clinical deterioration by the patient or managing health professional. A recent study of rapid up-titration of β blockers in 49 patients with chronic heart failure reported that deterioration in symptoms, including weight gain, oedema of the legs, and increasing dyspnoea, were usually present eight to 12 days before admission to hospital.[29]

The lack of effect of remote monitoring programmes on all cause admissions to hospital may require further exploration. This observation is consistent with an earlier meta-analysis.[6] Importantly this result does not simply reflect a paucity of data as there were more events for this end point (1561 admissions in 3586 patients) than for deaths and admissions to hospital. Reduced mortality will increase the duration of exposure to the risk of admission and will reduce the effect of intervention on this outcome. However, telemonitoring is likely to produce false alarms and pre-emptive admissions in patients who are deteriorating but not yet in crisis and also to lead to early discharge because the patient still has a high level of monitoring at home. Consequently, telemonitoring may be more effective at shortening hospital stay than at reducing admissions. Increased survival and admissions for common comorbid conditions (for example, chronic respiratory disease, fractures from falls, and cancer among participants who were typically elderly)[30] may also prevent a reduction in the frequency of admissions associated with telemonitoring. Finally, remote monitoring in patients with chronic heart failure focuses on indices specific to that disease and treatment; it may have little effect on other reasons for admission. Whether extending the range of monitoring to provide more comprehensive support will result in a further improvement in health outcomes is yet to be determined.

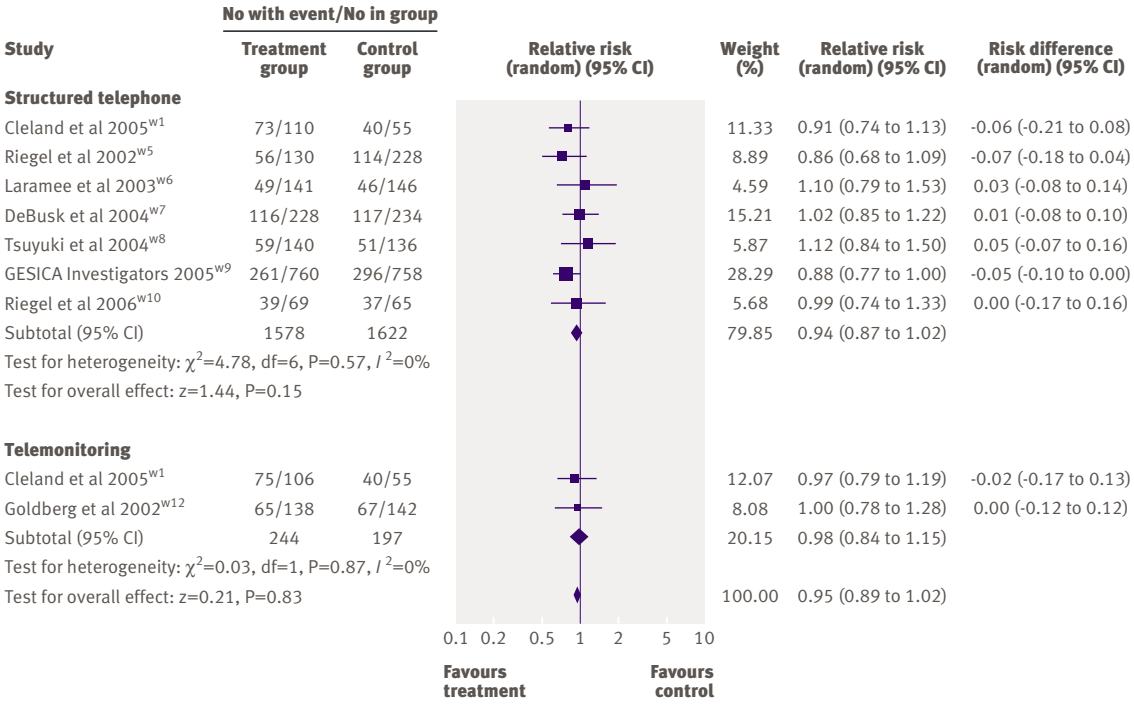

Fig 3 | Effect of remote monitoring on risk of all cause admission to hospital

WHAT IS ALREADY KNOWN ON THIS TOPIC

Systematic reviews on telephone support and telemonitoring in patients with chronic heart failure have provided inconclusive evidence of benefit

WHAT THIS STUDY ADDS

Remote monitoring has the potential to improve clinical outcomes in community dwelling patients with chronic heart failure

Quality of life, acceptability, and cost benefits were infrequently reported in these trials. Although those reporting these outcomes showed significant improvements with remote monitoring, future studies of telemonitoring or structured telephone support programmes should be encouraged to incorporate such measures and outcomes in their reporting. The same caveats and recommendations apply to cost data arising from these studies.

Limitations of the study

A limitation of this review is the relatively small number of studies (n=14) and participants (n=4264). In addition, few trials had follow-up beyond six months. Thus our observations on the positive, short term benefits of remote monitoring programmes may not extend to longer term outcomes. However, the hazard ratio for admission to hospital in patients with chronic heart failure is not linear as the greatest risk of readmission in such patients occurs in three to six months. Nevertheless, it is expected that the body of evidence on remote monitoring for chronic heart failure will expand considerably in the next decade as strategies on communicating information become normalised into medical practice and a better understanding is gained of the content of care provided by remote monitoring.

Furthermore, it is anticipated that the following studies will add to the evidence base in this specialty: the as yet unpublished reports on the home or hospital in heart failure[31] trial, which showed an overall neutral effect on mortality and admissions to hospital; the recent work by the Scalvini et al team in Italy,[32] which showed a significant reduction in risk of readmission (risk ratio 0.50, 95% confidence interval 0.34 to 0.73; P=0.01); and Riegel et al's[w10] most recent paper, which questions the effect of this type of intervention in non-Caucasian ethnic groups.

Conclusion

Although we have shown substantial and statistically significant benefits with remote monitoring for patients with chronic heart failure, monitoring is not a treatment but rather a different way of systematically organising effective care. Thus programmes that include remote monitoring should not be seen as a replacement for specialist care[8] or multidisciplinary chronic heart failure clinics (two interventions that improve outcomes[6 33]). However, remote monitoring may be of particular benefit to patients who have difficulty accessing specialised care because of geography, transport, or infirmity.[8 34]

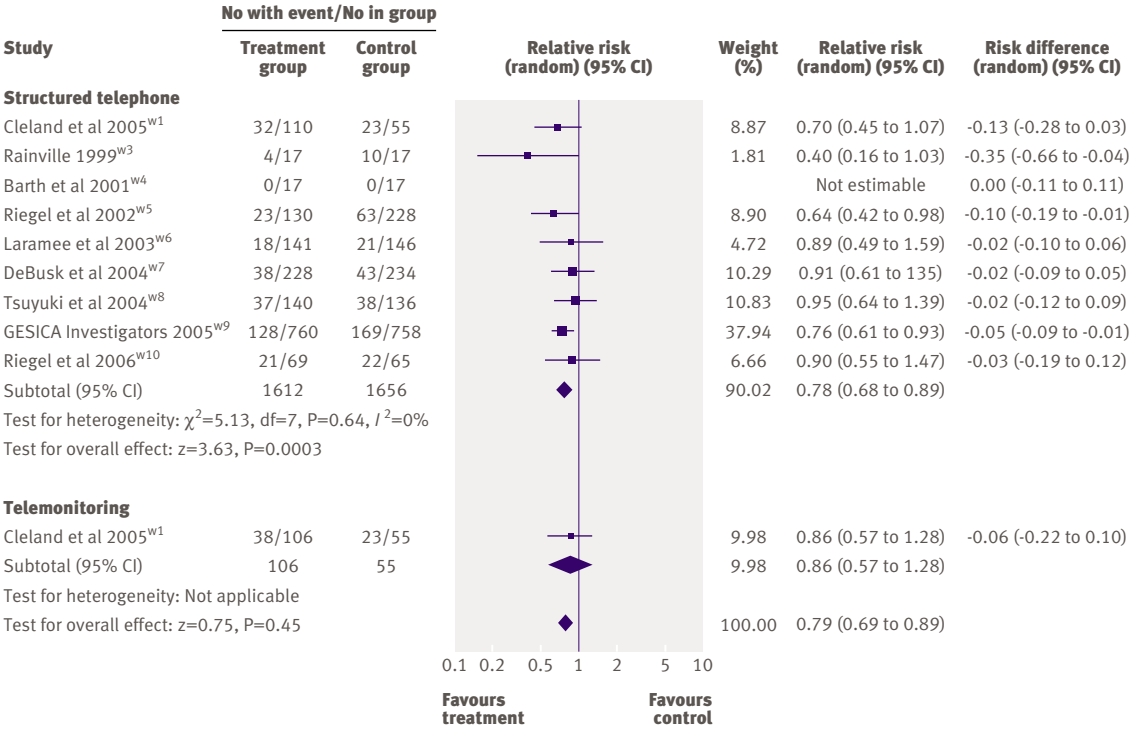

Fig 4 | Effect of remote monitoring on risk of admission to hospital for chronic heart failure

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Contributors: RAC conceived and designed the study. RAC and SCI reviewed the literature, developed the study protocol, and searched for and abstracted the data. RAC, SCI, SS, and JGFC analysed and interpreted the data. FAMcA assessed the quality of extracted data and was responsible for synthesis and analysis of the data. He will act as guarantor. JGFC hand searched the literature and referred experts to RAC and SCI. All authors contributed to the drafting of the article and revising it for important intellectual content.
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Ethical approval: Not required.

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Table 1 | Description of studies included in systematic review and meta-analysis

Study	Participants (location)	Interventions and usual care	Reported outcomes (study end point)	Study quality			
				Randomisation	Allocation concealment	Blinding of patients and assessors	Completeness of follow-up
Structured telephone (on basis of symptom reporting) and telemonitoring (on basis of symptom and sign monitoring):							
Cleland et al 2005 (TEN-HMS study)[w1]	426 patients (mean age 67 years) with a recent admission for heart failure and left ventricular ejection fraction <40% (Germany, Netherlands, United Kingdom)	Patients assigned to nurse telephone support arm received a telephone call each month by a heart failure specialist nurse to assess symptoms and current drugs. Patients assigned to telemonitoring received nurse telephone support and had their weight, blood pressure, and electrocardiogram monitored twice daily. Usual care consisted of a management plan forwarded to patient's primary care physician, who was asked to implement it. If the practice involved nurse titration of drugs this was allowed. Patients were assessed at a research clinic every four months; contact with clinic was discouraged between visits	Mortality, readmission to hospital, compliance with intervention (15 months)	Random permuted blocks	After consent and collection of baseline data an independent statistical centre was contacted	NS	1% lost to follow-up
Structured telephone (on basis of symptom reporting):							
Gattis et al 1999 (PHARM study)[w2]	181 patients (mean age 67 years) with heart failure being evaluated in cardiology clinic (United States)	Clinical pharmacist led drug review and patient education. Regularly scheduled telephone contact (at 2, 12, and 24 weeks) to detect clinical deterioration early. Control group received usual care that did not include pharmacist providing recommendations on drug therapy to attending physician or providing education to patient. Patient assessment and education were provided by attending physician, physician assistant, or nurse practitioner. Patient was contacted by pharmacist by telephone to identify clinical events	Mortality, readmission to hospital, drug prescription (6 months)	Computer generated	Assignment revealed after provision of consent	Yes ; NS	NS
Rainville 1999[w3]	34 patients aged ≥ 50 years (mean age 70 years) discharged from hospital with heart failure (United States)	Usual care plus pharmacist led drug review, patient education, drug management before discharge and at days 3, 7, 30, and 90, and 12 months. Usual care consisted of routine care and preparation for discharge, including written prescriptions, physician discharge instructions, and nurse review of diet, treatment plans, and drugs. Nurses provided patient with computer generated drug information sheets. Patients were contacted by a pharmacist at 30 days, 90 days, and 12 months to determine readmissions	Mortality, readmission to hospital, functional assessment score (12 months)	Method not stated	Unclear	Yes ; NS	2.9% lost to follow-up
Barth et al 2001[w4]	34 patients (mean age 75 years) discharged from acute care to home with primary diagnosis of chronic heart failure (United States)	Structured nurse managed telephonic post-discharge programme involving predischarge education plus post-discharge telephone follow-up. Structured interaction at 72 hours, 144 hours, and then fortnightly. Control group received routine discharge teaching at time of discharge as per hospital procedure. Patients were contacted at 2 months for collection of data	Mortality, readmission to hospital, physician and emergency department visits, quality of life, cost of intervention (3 months)	Method not stated	Unclear	NS	NS
Riegel et al 2002[w5]	358 patients (mean aged 74 years) discharged from hospital with heart failure (United States)	Telephonic case management by registered nurse using decision support software, involving patient education and counselling and liaison with primary care physician. Patients were telephoned within 5 days of discharge and thereafter at a frequency guided by software and case manager (mean 17 calls). Usual care was not standardised, and no formal telephonic case management was in existence at these institutions. These patients presumably received some education on heart failure management before hospital discharge	Mortality, readmission to hospital, physician and emergency department visits, inpatient costs, patient satisfaction (6 months)	Physicians were unit of randomisation, method not stated	Unclear	Physicians blinded ; NS	NS
Laramee et al 2003[w6]	287 patients (mean age 71 years) admitted to hospital with primary or secondary diagnosis of chronic heart failure, left ventricular systolic dysfunction <40% or radiological evidence of pulmonary oedema (United States)	Telephonic case management carried out by one nurse case manager for chronic heart failure, involving four major components: early discharge planning, patient and family education on chronic heart failure, promotion of optimal drugs for chronic heart failure and 12 weeks of telephone follow-up. Usual care consisted of standard care typical of a tertiary care hospital. It included inpatient social service evaluation (25%), dietary consultation (15%), physiotherapy or occupational therapy (17%), and education on drugs and chronic heart failure by nurses. Post-discharge was carried out by the patient's local physician (44% received some home care services)	Mortality, readmission to hospital, inpatient and outpatient costs, drug prescription and adherence (3 months)	Simple randomisation of first 42 patients, followed by randomisation in blocks of eight	Unclear	NS	5.2% lost to follow-up
DeBusk et al 2004[w7]	462 patients (mean age 72 years) admitted to hospital with provisional diagnosis of chronic heart failure from Kaiser Permanente (United States)	Standardised telephonic physician directed nurse managed case management, involving lifestyle education and drug management for chronic heart failure. Patients contacted weekly for 6 weeks, biweekly for 8 weeks, and then monthly and bimonthly. Usual care not clearly defined, but was provided by participating Kaiser Permanente medical centres, seemed to involve a high frequency of all of kinds of follow-up clinic visits (13 in 12 months after admission to hospital)	Mortality, readmission to hospital, emergency and outpatient department visits, prescription of recommended pharmacotherapy (12 months)	Sealed assignment using Efron procedure	Research staff not associated with delivering intervention provided sealed assignment	NS ; Yes	NS

Tsuyuki et al 2004[w8]	276 patients (mean age 72 years) discharged from hospital with heart failure (Canada)	Early discharge planning with provision of adherence aids, patient education, regularly scheduled telephone contact with local research coordinator at 2 and 4 weeks then monthly thereafter for 6 months. Recommendations to see primary care physician if not receiving target dose of angiotensin converting enzyme inhibitor or deterioration. Patients assigned to usual care received a pamphlet on general heart disease before discharge, but no formal counselling beyond what was routine at the hospital. Patients were contacted monthly for 6 months to ascertain clinical events	Mortality, readmission to hospital, drug adherence, physician and emergency department visits, cost analysis (6 months)	Computer generated sequence using block randomisation stratified by study site	Randomised by a telephone call to project office	NS	2.5% lost to follow-up
GESICA Investigators 2005 (DIAL trial)[w9]	1518 outpatients (mean age 65 years) with stable chronic heart failure (Argentina)	Nurses trained in management of patients with chronic heart failure carried out structured telephone follow-up involving adherence to diet and treatment, monitoring of symptoms, control of fluid retention, and daily physical activity. Patients were contacted four times in the first fortnight and then as needed. Patients in control group were followed by their attending cardiologists and received care similar to the intervention group	Mortality, readmission to hospital, quality of life (mean 16 months)	Permuted block randomisation using concealed randomisation lists, stratified according to patient's cardiologist	After provision of consent, patient's cardiologist contacted study centre	NS ; Yes	0.5% lost to follow-up
Riegel et al 2006[w10]	134 Hispanic patients (mean age 72 years) admitted to hospital with chronic heart failure (United States)	Education, monitoring, and guidance by bilingual-bicultural Mexican-American registered nurses by telephone case management standardised using decision support software. Patients were contacted on average within 5 days of discharge and thereafter at a frequency guided by the software and nurse case manager over a 6 month period (mean 13.5 calls to patients and 8.4 additional calls to families). Printed educational material was provided monthly and on request in relevant language. Usual care was not standardised and no formal disease management programme existed at these institutions. Standard of usual care was that patients were educated about heart failure management before discharge, assuming that nurse spoke patient's language or someone bilingual was available to translate. In reality, only a small portion of staff were bilingual so much of the discharge instruction was provided in writing. Typical discharge instructions included a drug list and institution specific discharge instruction sheet with handwritten notes to follow a low sodium diet and contact the physician if symptoms occur	Mortality, readmission to hospital, cost of care, self reported health related quality of life and depression (6 months)	Sealed envelopes attached to sequential data forms	Sealed envelopes opened after collection of baseline data	NS ; Yes	No losses to follow-up
Telemonitoring (on basis of symptom and sign monitoring):							
De Lusignan et al 2001[w11]	20 patients (mean age 75 years) with heart failure confirmed by cardiologist, identified from database of academic general practice (United Kingdom)	Telemonitoring of vital signs (pulse, blood pressure, weight) and clinical status assessed daily by nurses along with video consultations with a nurse weekly for 3 months, fortnightly for 3 months, then monthly. Usual care consisted of standard general practice treatment; in addition they had pulse, blood pressure, and weight measured quarterly. They were evaluated in the same manner as the intervention group	Mortality, compliance with intervention and drugs, patient satisfaction, quality of life (12 months)	Random table allocation	Unclear	NS	NS
Goldberg et al 2002 (WHARF trial)[w12]	280 patients (mean age 59 years) admitted to hospital with NYHA class III-IV, with left ventricular ejection fraction ≤35% (United States)	Daily transmission of weight and symptoms using a customised monitor; data were reviewed daily by nurses and concerns reported to physician. Patients in control group were instructed to contact their physician for weight increases of more than a prespecified amount or if their symptoms of heart failure worsened. They had a weight log to bring to visits. Follow-up visits, other than study visits, were at the discretion of the treating physician. Telephone contacts were permitted at the discretion of the treating physician or nurse	Mortality, readmission to hospital, emergency department visits, quality of life, patient satisfaction, compliance with intervention (mean 6 months)	Method not stated	Unclear	NS ; Yes	11% lost to follow-up
Woodend et al 2003[w13]	121 patients (mean age 68 years) with symptomatic heart failure (NYHA class II or greater) (Canada)	Daily transmission of weight and periodic transmission of electrocardiogram and blood pressure. Weekly video conferences by telehome care nurse. Video conferences more frequent in first few weeks and tapered over 3 months. Usual care was not described	Mortality, readmission to hospital, quality of life, emergency department visits, patient satisfaction (3 months)	Method not stated	Unclear	NS	NS
Capomolla et al 2004[w14]	133 patients (mean age 57 years) discharged from specialist chronic heart failure unit to home (Italy)	Daily communication of vital signs (including weight, systolic blood pressure, heart rate) and symptoms with review by nurses and physicians. Access to medical staff by phone as needed was available. Usual care consisted of referral to patient's primary care physician or cardiology department at discharge. Post-discharge care was governed by care provider	Mortality, readmission to hospital, emergency department visits, compliance with intervention (12 months)	Method not stated	Unclear	NS	NS

NYHA=New York Heart Association. NS=Not stated.