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

Robyn A Clark,[1] Sally C Inglis,[2] Finlay A McAlister,[3] John G F Cleland,[4] Simon Stewart[5]

EDITORIAL by Grancelli and Ferrante

[1]Division of Health Sciences, University of South Australia, Adelaide, Australia
[2]Faculty of Health Sciences, University of Queensland, Brisbane, Australia
[3]Division of General Internal Medicine, University of Alberta, Edmonton, Canada
[4]Academic Cardiology, University of Hull, Hull
[5]Preventative Cardiology Unit, Baker Heart Research Institute, Prahran, Melbourne, Vic 3004, Australia
Correspondence to: S Stewart
simon.stewart@baker.edu.au

BMJ 2007;334:942-5
doi: 10.1136/bmj.39156.536968.55

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

The effectiveness of multidisciplinary non-pharmacological approaches for improving outcomes in patients with chronic heart failure has been well established.[1-5] It is clear, however, that within most populations access to these programmes is limited by barriers related to funding or geography.[6] Consequently interest is increasing in remote monitoring models for delivering care, either as telemonitoring (transfer of physiological data 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 data transfer.[4]

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.[3 4] 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 this differed by the technology used to communicate information.

METHODS

We updated two earlier systematic reviews that dealt with telemonitoring[3 4] by searching 15 electronic databases using search methods recommended by the Cochrane Heart Review Group (see bmj.com for search strategy and keywords).[7] All randomised trials evaluating remote monitoring programmes published between 1 January 2002 and 6 May 2006 were included.

Remote monitoring programmes initiated by a health professional for patients with chronic heart failure living at home were eligible for inclusion if the monitoring was carried out at least once in the month after hospital discharge, was targeted towards the patient (the patient was the person on the telephone), was structured (not "as needed"), and was to be delivered as the only aftercare intervention without home visits or more than usual clinic follow-up. We a priori classified programmes as structured telephone support if they consisted of standardised telephone contact of patients 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 at least once during follow-up), and rate of admission as a result of chronic heart failure (proportion of patients readmitted at least once during follow-up). Our secondary outcomes were health related quality of life, cost, and acceptability.

As the outcomes of interest were relatively common we calculated risk ratios and the risk difference,[7] with 95% confidence intervals. We carried out intention to treat analyses. We used Cochran's Q test and I^2 statistic to assess heterogeneity in each outcome.

RESULTS

Overall 234 of 499 citations were reviewed in detail. Of these, 14[w1-w14] randomised controlled trials (4264 patients) were eligible for inclusion (see bmj.com). To avoid double counting the control patients in one trial with three arms[w1] the results for the control arm were shared between the two comparisons for the pooled analysis of all remote monitoring programmes, but the controls were counted in each of the subanalyses (each intervention *v* usual care). Four trials evaluated telemonitoring,[w11-w14] nine evaluated structured telephone support,[w2-w10] and one evaluated both.[w1]

The length of follow-up ranged from three to 16 months, the mean ages of participants ranged from

This article is an abridged version of a paper that was published on bmj.com on 10 April 2007. Cite this version as: *BMJ* 10 April 2007, doi: 10.1136/bmj.39156.536968.55 (abridged text, in print: *BMJ* 2007;334:942-5)

57 to 75 years, and all trials enrolled patients with symptoms (see bmj.com). Structured telephone support included monitoring of symptoms, medicine management, and education and counselling on lifestyle. All the telemonitoring programmes included transfer of daily data.

Quantitative data synthesis

All cause mortality

All 14 trials reported all cause mortality (15 comparisons, 581 deaths, fig 1) .The pooled estimates showed a statistically significant 20% reduction (95% confidence interval 8% to 31%) with remote monitoring. 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 achieve significance (P=0.18). 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 2), none reported a statistically significant result. Even the pooled estimates did not show a significant benefit (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. Although only one reported a statistically significant benefit, all 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 (fig 3). 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 reduces 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 (see bmj.com). Three reported a significant and substantial improvement in quality of life between the intervention and control groups. 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 (see bmj.com). The cost of the intervention was infrequently reported and variation existed between programmes (see bmj.com).

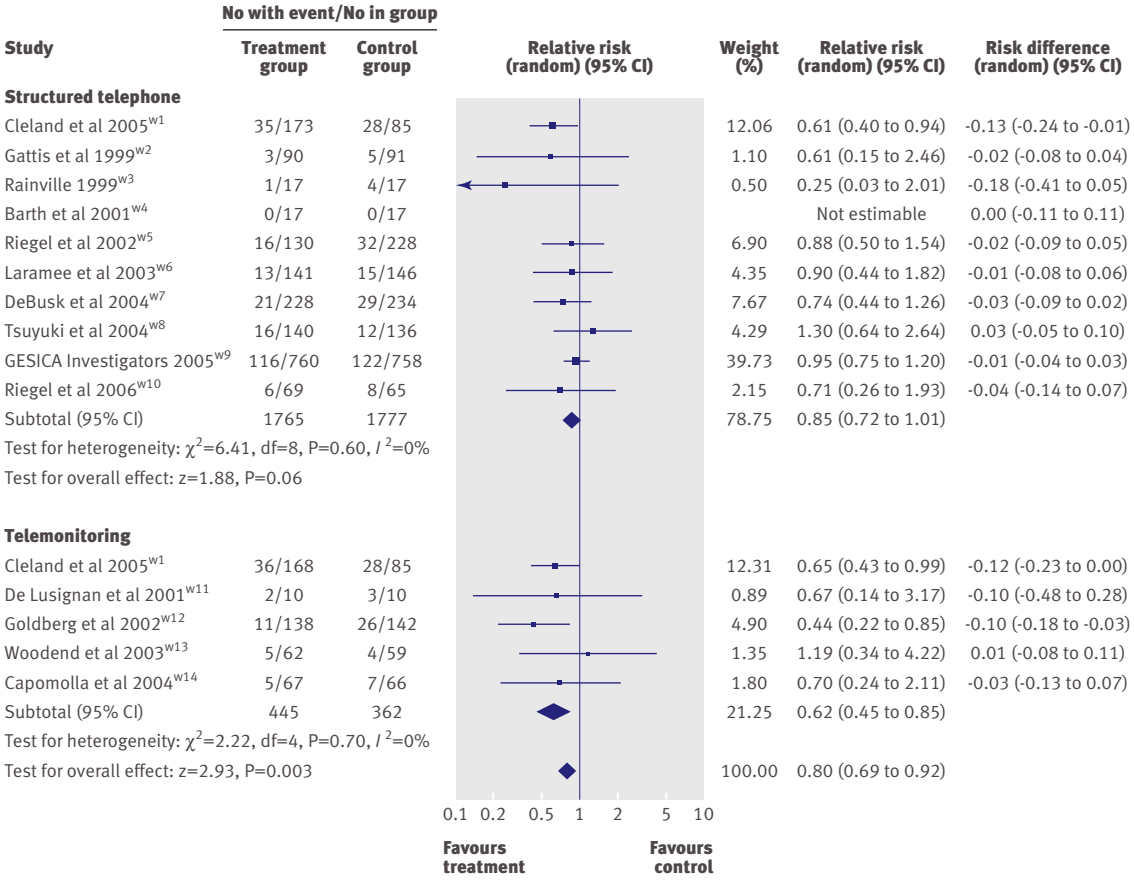

Fig 1 | Effect of remote monitoring on all cause mortality

None of the telemonitoring trials reported on costs. Acceptability of the intervention to the patient was under-reported, with only four trials reporting this outcome (see bmj.com).

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 the two previous reviews[3 4] of multidisciplinary interventions for chronic heart failure.

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 early triage of patients by telemonitoring nurse 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 times to healthcare providers, thus potentially leading to earlier detection and management of clinical deterioration by patients or managing health professionals.

The lack of effect of remote monitoring programmes on all cause admissions to hospital is consistent with an earlier meta-analysis.[4] This result does not simply reflect a paucity of data as there were more events for this end point 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 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.

Quality of life, acceptability, and cost benefits were infrequently reported. Although those reporting these outcomes showed significant improvements with remote monitoring, future studies of remote monitoring should incorporate such measures and outcomes.

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 may not extend to longer term outcomes. However, the hazard ratio for admission to hospital in patients with chronic heart

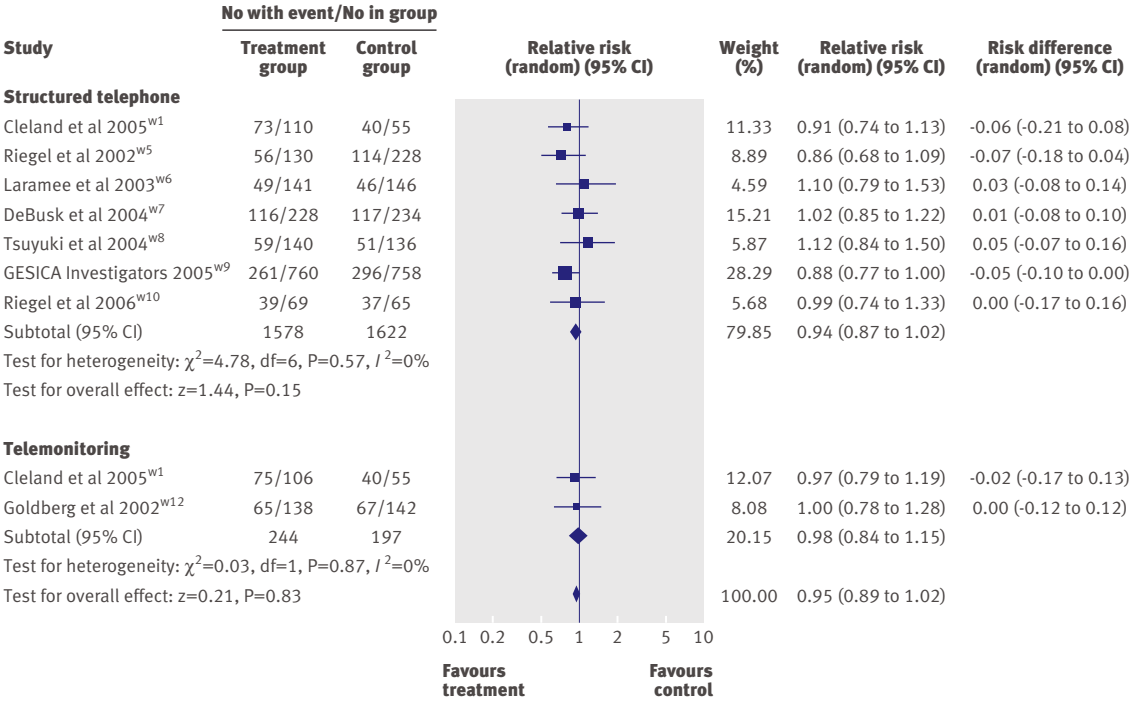

Fig 2 | Effect of remote monitoring on risk of all cause admission to hospital

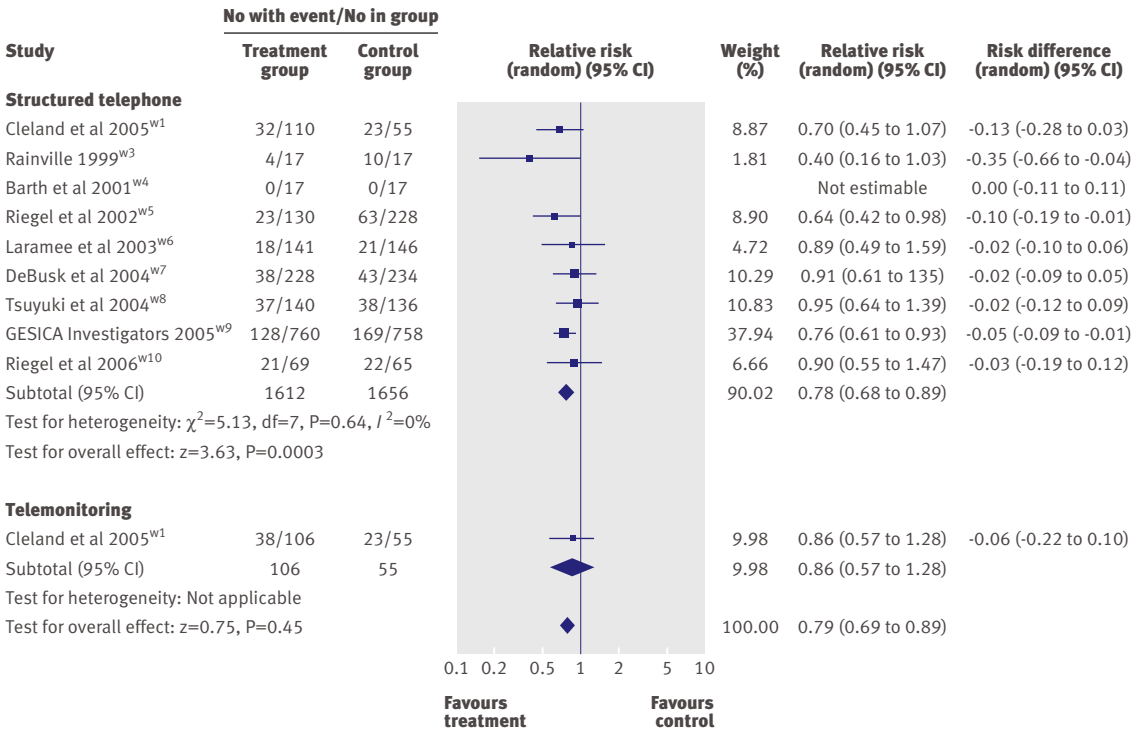

Fig 3 | **Effect of remote monitoring on risk of admission to hospital for chronic heart failure**

failure is not linear as the greatest risk of readmission in such patients occurs in three to six months.

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 another way of organising effective care. Thus programmes that include remote monitoring should not be seen as a replacement for specialist care[6] or multidisciplinary chronic heart failure clinics (two interventions that improve outcomes[4 8]). However, remote monitoring may be of benefit to patients who have difficulty accessing specialised care because of geography, transport, or infirmity.[6 9]

We thank librarian Margaret Goedhart (University of South Australia) for her knowledge and skill in navigating bibliographies and electronic sources, and the following investigators for further data and information from their studies: WA Gattis, LR Goldberg, A Laramee, B Riegel, RT Tsuyuki, A Woodend, and S Scalvini.

Contributors: See bmj.com.
Funding: RAC is supported by the National Institute of Clinical Studies and the National Heart Foundation of Australia. SCI and SS are supported by the National Health and Medical Research Council and the National Heart Foundation of Australia. FAMcA receives salary support from the Alberta Heritage Foundation for medical research population health scholar programme, the Canadian Institutes of Health Research new investigator programme, and the University of Alberta/Merck Frost/Aventis chair in patient health management. JGFC (within the past five years) was principal investigator transEuropean network homecare management system study and received research funds from the European Union and Phillips Healthcare to carry out the study and has received honorariums from Phillips for speaking on telemonitoring. JGFC is a consultant to the EU sponsored MyHeart project which is part funded by Phillips and other manufacturers of telehealth devices.
Ethical approval: Not required.

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

1 Gonseth J, Guallar-Castillon P, Banegas JR, Rodriguez-Artalejo F. The effectiveness of disease management programmes in reducing hospital re-admission in older patients with heart failure: a systematic review and meta-analysis of published reports. *Eur Heart J* 2004;25(18):1570-95.
2 Gwadry-Sridhar FH, Flintoft V, Lee DS, Lee H, Guyatt GH. A systematic review and meta-analysis of studies comparing readmission rates and mortality rates in patients with heart failure. *Arch Intern Med* 2004;64:2315-20.
3 Louis AA, Turner T, Gretton M, Baksh A, Cleland JGF. A systematic review of telemonitoring for the management of heart failure. *Eur J Heart Fail* 2003;5:585-90.
4 McAlister FA, Stewart S, Ferrua J, McMurray JJV. Multidisciplinary strategies for the management of heart failure patients at high risk for admission: a systematic review of randomized trials. *J Am Coll Cardiol* 2004;44(4);810-9.
5 Phillips CO, Wright SM, Kern DE, Singa RM, Sheppard S, Rubin HR. Comprehensive discharge planning with post discharge support for older patients with congestive heart failure: a meta-analysis. *JAMA* 2004;291(11):1358-67.
6 Jaarsma T, Stromberg A, De Geest S, Fridlund B, Heikkila J, Martensson J, et al. Heart failure management programmes in Europe. *Eur J Cardiovasc Nurs* 2006 ;5:197-205.
7 Higgins JPT, Green S, eds. Cochrane handbook for systematic reviews of interventions. In: *Cochrane Library*. Issue 4. Chichester: John Wiley, 2006.
8 Ezekowitz J, van Walraven C, McAlister FA, Armstrong PW, Kaul P. Impact of specialist follow-up in outpatients with congestive heart failure. *CMAJ* 2005;172:189-94.
9 Cleland JGF. Patients with treatable malignant disease—including heart failure—are entitled to specialist care. *CMAJ* 2005;172:207-9.

Accepted: 19 February 2007