Telehealth: The effects on clinical outcomes, cost effectiveness and the patient experience: a systematic overview of the literature

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Telehealth

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Executive Summary

Telehealth is seen as a way of improving access to patient care for long term conditions and there is a considerable volume of published literature available. This report provides an overview of the best available evidence by summarising recent systematic reviews.

It was found that there is more evidence for some conditions than others, but on the whole the trends are largely positive suggesting that telehealth is effective in:

- Reducing patient mortality and hospital admissions for chronic heart failure
- Reducing hospital admissions for COPD
- Reducing blood pressure in hypertension, improving glycaemic control in diabetes and reducing symptoms in asthma

For a wide range of other clinical outcomes and across conditions, telehealth seems to be as good as usual patient care, suggesting that it is fulfilling its promise of increasing access to services.

Patients appear to be satisfied with telehealth services across a wide range of conditions, although there may be a need for considering individual patient requirements in some contexts.

However there is a debate regarding the quality and nature of evaluations of telehealth systems and this cannot be ignored. Repeated systematic reviews have commented on the quality of evaluations.

Future evaluations should incorporate mixed methods or a realist approach to examine what works for whom and why; this may well provide the way forward in examining in more depth the more meaningful effects of telehealthcare.

Introduction

This report seeks to provide a quick but rigorous literature review examining the clinical outcomes, cost effectiveness and patient views of telehealth systems for long term conditions.

Telehealth is a wide field and recent years have seen an increasing amount of published studies seeking to ascertain its effectiveness [1]. There are many definitions of telehealth [2] and within the literature the terms telecare, telemonitoring and telemedicine are often used interchangeably. Papers on the topic frequently discuss and study a range of systems together. This myriad of definitions together with a high volume of heterogeneous studies makes reviewing and making sense of the evidence on the topic a challenge. This is further complicated by the debate surrounding the quality of research in this field and the shortcomings of various methodologies for assessing telemedicine [3].

For the purposes of this report, the starting point was a wide and systematic search of the published literature using "*the management of long term conditions via remote monitoring of vital signs using equipment in the patients' home*" (http://www.tunstallgroup.com/) as a definition. Although a broader view of telehealth might include digital images, audio and videoconferencing for examination or consultation, the Tunstall definition is consistent with the UK Department of Health definition: '*Electronic sensors or equipment that monitors vital health signs remotely, e.g. in your own home or while on the move. These readings are automatically transmitted to an appropriately trained person who can monitor the health, vital signs and make decisions about potential interventions in real time, without the patient needing to attend a clinic*' [4].

Telehealth, as a modality for the delivery of health services and information, is being implemented in many regions across the world and is seen as a way of providing or improving access to quality health services, thereby leveling the health care playing field in deprived or geographically remote areas. The Department of Health has signalled its commitment to delivering telehealthcare through the launch of the *3millionlives* initiative [6] in January 2012 which is designed to deliver telehealth and telecare to three million people in the next five years. Perhaps the largest study around telehealth has been the Whole System Demonstrator project, which sought to provide a robust evidence-base for telehealth (and telecare: 'Personal and environmental sensors in the home that enable people to remain safe and independent in their own home for longer. 24 hour monitoring ensures that should an event occur the information is acted upon immediately and the most appropriate response put in train') [4]. This large-scale, multi-site randomised controlled trial was launched in 2008 and included 6191 patients with diabetes, COPD or heart failure. The early results from the trial indicated that 'if used correctly telehealth can deliver a 15% reduction in A&E visits, a 20% reduction in emergency admissions, a 14% reduction in elective admissions, a 14% reduction in bed days and an 8% reduction in tariff costs. More strikingly they also demonstrate a 45% reduction in mortality rates'.

This overview will draw on evidence from a wider literature base in an attempt to test out the generalisability of these early results.

Methods

A systematic literature search from 2000 onwards was undertaken using a range of electronic databases, selected to cover as broad a range of perspectives in the time frame available (see Appendix 1). To reduce the volume of literature that could potentially be included, the review criteria (Table 1) were applied in two stages (initial and revised). A high number of systematic reviews on the various aspects of telehealth were available, including a recent overview of systematic reviews [3, 5]. The breadth, depth and academic rigour of this recent overview enabled the team to move forward from this starting point and focus their research on subsequent systematic reviews in order to provide a broad overview of the best evidence available – a review of reviews.

Initial Inclusion Criteria	**Initial Exclusion Criteria**
Involved studies which met the definition: "The use of telecommunication technologies by patients for the timely transmission of data from a home to health care service centre" and 1. Required the patient or carer to periodically measure physiological indicators and/or record their symptoms/vital signs in a standardized format 2. Use telecommunication technologies that manually or automatically transferred data from patients home to health care service 3. Led to review of patients health status data 4. Involve a response when the data crossed a predefined threshold	Measurement of vital signs was taken by health care professionals, decision modelling, telecommunication between two clinicians, remote consultation
Any long term condition	**Acute conditions**
Collected data on the following outcomes – health benefits, mortality, morbidity, QoL, costs, unplanned re-admissions A&E visits, ambulance call outs, length of stay, out patient attendances, workforce efficiencies, clinical parameters for particular conditions (eg blood pressure for hypertension)	Clinical outcomes not reported
UK or international	
2000 onwards	Before 2000
Revised inclusion criteria	**Revised exclusion criteria**
Systematic reviews or Qualitative studies of patient experience or economic evaluations	Non systematic literature reviews, individual quantitative studies (RCTs, quasi experimental, evaluations)
Post 2010	Published prior to 2010

Table 1: Inclusion/Exclusion Criteria

Figure 1 demonstrates the methods used to manage the literature via a searching and screening process to obtain the final set of systematic reviews included in this

report. To reduce bias in the selection process all titles and abstracts were screened by two people, potentially relevant articles were obtained and screened by one of a team of three people using agreed criteria, data for those meeting the inclusion criteria were extracted by one of a team of four people following an agreed approach onto predefined forms. Extracted data was combined onto a series of data tables and used to provide the narrative synthesis. Full details of searches can be found in Appendix 1.

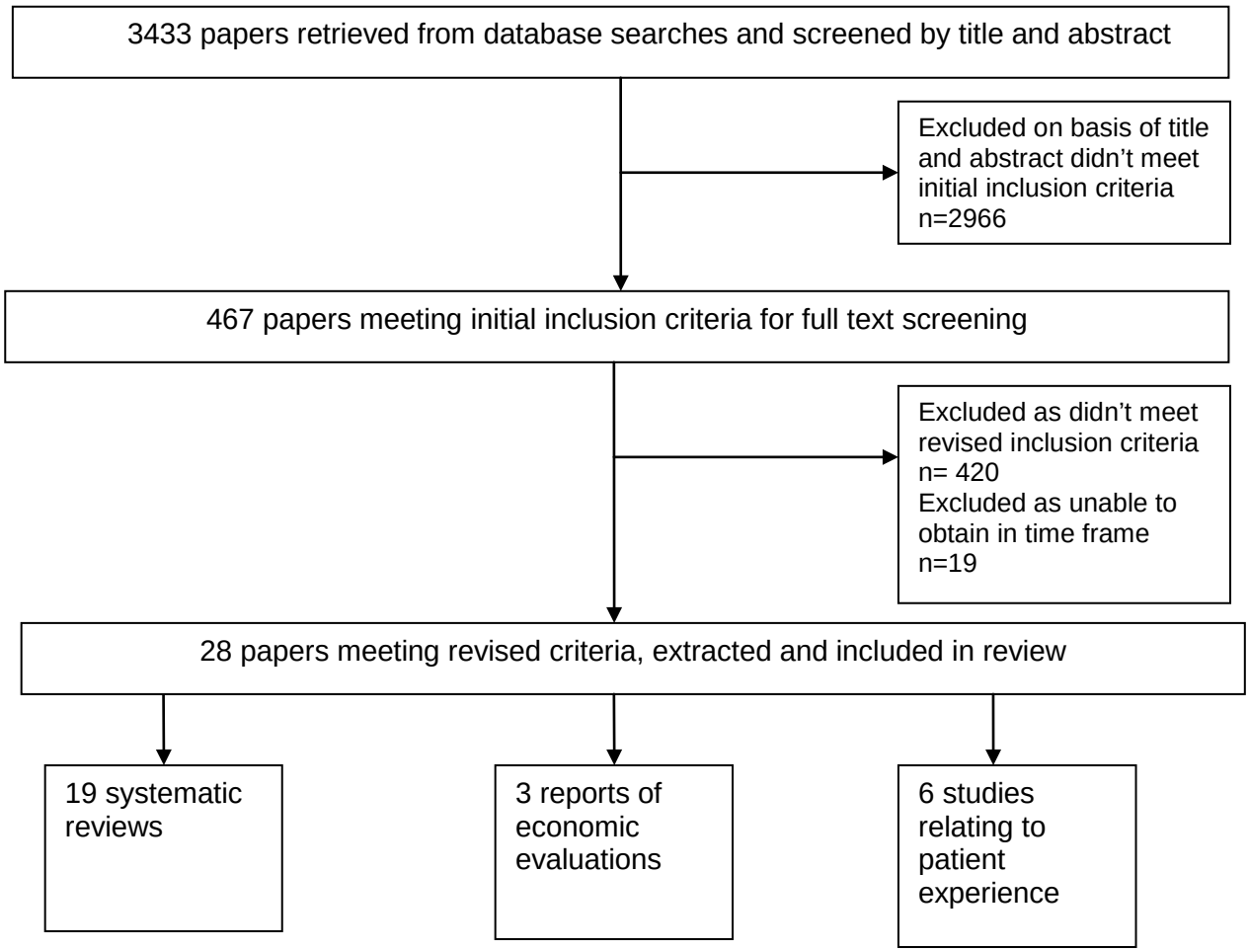

Figure 1: Flow diagram of literature search and screening and exclusion process

Results

Overview of the evidence

A total of 467 individual papers were identified as potentially relevant for inclusion in this literature review (following the initial criteria in Table 1). This included a high number of systematic reviews of various aspects of telehealthcare, including an overview of reviews of telemedicine up to 2010 [3, 5]. In order to fully utilise the short time frame available the overview [5] [3] was employed as a starting point, and is described separately below. Then, a narrative summary of the evidence from 19 systematic reviews, together with three economic evaluations and six patient view studies published since 2010 are presented for a wide range of clinical outcomes.

The quality of the reviews included in this report was mixed from high quality Cochrane reviews [8-11] and high level overviews [1], to smaller scale reviews limited to one source of evidence [12]. A number of the reviews highlighted concerns about the quality of evidence available [1, 3, 13], this included the short term nature of the evaluations undertaken, the small sample sizes, the wide range of outcomes collected, the heterogeneous nature of the studies (making studies difficult to compare); and a lack of patient and economic perspectives. Invariably these factors need to be taken into account when considering the evidence and conclusions that are reported below. An overview of the studies included in this report is presented in Appendix 2.

Evidence for effectiveness of telehealth prior to 2010

A large scale EU funded project provided an overview of the evidence up to 2010 [3, 5]. The authors examined 80 systematic reviews on the effectiveness of telemedicine [5] and 50 systematic reviews to provide guidance on methodology [3]. Of these reviews, 26 met the definition of telehealth that we have used above, 9 suggested that the telehealth systems were effective, 8 suggested that telehealth had promise, as they demonstrated equivalent results to usual care and 9 provided limited and inconsistent evidence regarding telehealth. Economic effectiveness and patient satisfaction were also covered with 9 relevant papers suggesting that there is a lack of knowledge and understanding regarding costs around telehealth and 3 papers providing a mixed view of the evidence regarding patient satisfaction. For outcomes of interest here, the evidence prior to 2010 demonstrated a reduction in mortality and admissions in relation to chronic heart failure, as well as indicating that telehealth systems were feasible to use and that they were acceptable to patients. The study concluded that there was a need for larger scale studies of the predefined effects of controlled telemedicine interventions but acknowledged that such studies cannot address all emerging questions about telehealth. Future studies should consider telehealth as a complex intervention and utilise mixed method approaches to evaluation, which consider the outcomes relevant to the specific context. It was also recommended that assessments, which engage all stakeholders and consider all the economic benefits should be conducted in natural settings.

Evidence of effectiveness post 2010

Clinical outcomes

Mortality

Of the 19 reviews included here, eight examined whether telehealth interventions made a difference to mortality rates; For heart failure four reviews suggested that telehealth reduced mortality [11, 14-16] and a further two reported no differences between telehealth and the usual patient care [12, 13]. With regard to Chronic Obstructive Pulmonary Disease (COPD) two reviews reported no shown differences

between telehealth and the usual patient care for COPD [7, 9].

Hospital admissions
Nine reviews examined whether telehealth made a difference to patient hospital admission rates. For heart failure, four reviews demonstrated a reduction in hospital admissions [7, 11, 12, 16] and two showed no difference between telehealth and the usual care for admissions [13-15]. In the case of COPD, two reviews suggested that telehealth was effective in reducing hospital admissions [9, 17].

Bed days
Five of the reviews reported on bed days taken or length of stay in hospital for the patient. In the case of heart failure the conclusions appear to be mixed, with two reporting a reduction in the length of in-patient stay [12, 16] and two reporting no difference [11, 14]. Polisena et al [17] also reported a neutral effect for length of stay in COPD.

A&E
Only one review examined patient visits to A&E [14] and this review reported no difference between the usual level of care and telehealth for congestive heart failure.

GP visits
The evidence for the effectiveness in terms of GP visits is neutral with three studies showing no difference between telehealth and usual patient care for hypertension [18], congestive heart failure [16] and asthma [10]. These findings are illustrated in Table 2

There was more evidence available for congestive heart failure than other long-term conditions. Overall the evidence suggests that telehealth is effective at reducing mortality and hospital admissions for congestive heart failure. With regard to other outcomes, the evidence is suggesting that Telehealth is as effective as usual care for reducing the length of in-patient stay; A&E visits or visits to the GP. For other conditions, such as COPD two reviews have suggested that telehealth reduces patient admissions and a range of studies suggest that telehealth is as effective as usual care for mortality and bed days.

Key points – clinical outcomes

- Evidence suggests that Telehealth is more effective than usual care for some outcomes and as effective as usual care for others.
- For congestive heart failure telehealth reduces mortality and hospital admissions, and is as effective as usual care for bed days, visits to the GP and A&E visits (4 reviews)
- For COPD telehealth reduces hospital admissions and is as effective as usual care in terms of patient mortality, admissions and bed days (2 reviews)

Condition specific outcome measures and quality of life
Of the 19 systematic reviews, specific outcomes for particular conditions were reported in six and a further six reported on quality of life indicators more generally.

For hypertension, three reviews reported that telehealth was effective in reducing blood pressure [13, 18, 19] and one found no difference between telehealth and the usual method of care.

One review reported an increase in the use of antihypertensive drugs [19]. For diabetes two reviews reported improvements in glycaemic control [13, 20] yet no evidence was found of improved BMI or self-efficacy [20]. For asthma, significant improvements in peak expiratory flow were reported in one review [13] and similar results to the usual patient care in another [10]. Two of the reviews reported reductions in the symptoms of asthma [7, 13] and evidence of similar results to the usual patient care for quality of life more generally for asthma [10] and COPD [17].

Heart failure results are similarly mixed with one review suggesting that seven studies reported no difference in patient quality of life and five studies reporting positive increases in patient quality of life [16]. A further review reported that two thirds of studies suggested telehealth made no difference to medication adherence and one third of the studies reported that telehealth improved adherence and quality of patient life [14]. Wooton, in an overview of systematic reviews and randomised controlled trials for a number of long term conditions [1], concurs with these mixed results from different studies suggesting that the evidence for this wide range of outcomes is "weakly positive" in favour of telehealth. These results are illustrated in Table 3.

Key points – condition specific outcomes

- Telehealth is effective for reducing blood pressure in hypertension (3 reviews), improving glycaemic control in diabetes (2 reviews) and reducing symptoms in asthma (2 reviews)
- Telehealth can be as effective as usual care for generally improving quality of life across a range of conditions

Economic evaluations

Four of the systematic reviews reported on outcomes relating to costs [7, 9, 11, 14] and a further three papers specifically focused on costs and the economics of telehealth interventions [21-23]. For COPD two studies [7, 9] found limited evidence that telehealth was associated with reduced costs, however it was unclear which elements were included in the analysis. Similar evidence was also found in studies relating to heart failure [11, 14]. One study [21] derived an economic model in relation to heart failure which suggests that telehealth results in fewer hospital admissions and thus leads to cost savings, but again it was unclear which elements were included. Madsen [23] reported that medication and consultation costs were reduced for blood pressure monitoring when utilising telehealth, but these benefits were offset by the costs of implementing the necessary equipment. Similar findings were found in relation to diabetes [22], although the US context in this study may limit the applicability of these findings. These findings are very much in line with previous studies [1, 5] which found limited evidence on the cost effectiveness of telehealth, due to the nature of the evaluations which have been undertaken. One offered advice for future studies [5] including the need to develop studies which take into account multiple perspectives such as societal and organisational costs to provide a more

accurate picture of the economic benefits of telehealth.

Key points – economic evaluations

- There is some evidence that telehealth can reduce costs, however it is important to bear in mind the costs of implementing the systems when costs are calculated
- Much more research on the economics of telehealth interventions is needed. This should include cost benefit analyses which take into account a wide range of perspectives

Patient views

A range of evidence was found relating to patient views of telehealth. Five of the systematic reviews included a patient satisfaction component [14, 16-18, 20], one review focused solely on patient satisfaction studies [24] and five other individual studies were extracted in line with inclusion criteria [25-29]. All reported positive effects of patients' satisfaction with telehealth, although one review noted that the evidence was characterised by poorly constructed questionnaires [24] and another suggested that implementation of telehealth should be around patients' specific needs for example those who were anxious may have different requirements [26].

Two in-depth qualitative studies [28, 27] provided a wider perspective and clearly illustrated the barriers and success factors involved in using and implementing telehealth systems from both patients' and an organisational perspective. The evidence for patient satisfaction was most established in relation to heart failure with four studies reporting patient satisfaction [14, 16, 24, 27] including the acceptance of and confidence with the technology [14] and an increased awareness and confidence about their health condition [27]. Two further studies [18, 25] also demonstrated that patients accepted and were confident in using telehealth systems in relation to blood pressure monitoring for hypertension.

A qualitative study which covered a range of conditions [28] provided an insight into patients' perspectives of telehealth and found that patients had learned to use the equipment by trial and error; tended to comply with the equipment rather than it empower them and tended to think the system did the work of healthcare professionals. Patients also reported feeling less of a nuisance and appreciated the continuity of care and easier access to healthcare professional advice. An insight into professional and organisational issues around implementing telehealth arose from two studies suggesting that telehealth changes the workflow and relationships between clinicians and patients [27] and that a paradox of the reliance and acceptance of telecare is the creation of new relationships and dependencies [28]. An overview of the qualitative studies can be found in Table 4.

Key points – patient views

- Patients appear to be satisfied with telehealth services across a wide range of conditions.
- More in-depth studies of patient experience would provide an insight into organisational and professional factors involved in implementing telehealth systems and help improve the quality of any future evaluations to ensure that more meaningful outcomes are measured.

Discussion

Systematic reviews provide a comprehensive overview of the best quality evidence available on a topic area. By including only systematic reviews in this report, we aimed to provide an overview of the best available evidence for telehealth. The volume of evidence on telehealth is considerable and on the whole is positive [1, 13], providing either favourable clinical outcomes or demonstrating that telehealth is at least as good as conventional care.

We found a number of good quality systematic reviews but even well conducted systematic reviews are dependent on the evidence available. As with previous reviews [1, 5, 13] the evidence available on telehealth was found to be characterised by; short-term small evaluations, small sample sizes, inconsistent collection of outcome measures, varying definitions of telehealth and varying focus of reviews (making comparison between studies and reviews difficult). Clearly these factors need to be taken into account when interpreting the conclusions from this overview and could be the reason why reviews on the same topic, draw different conclusions.

However two reviews sought to address these issues and examined shorter [11] or larger scale [13] studies separately but still found similar trends in the evidence. A further concern is that telehealth is frequently compared with usual patient care, but this may not be the most appropriate comparison, as the telehealth intervention may well be very different from the usual care provided, and it could be said that any intervention which included more frequent monitoring of patients would lead to improved outcomes and increased costs. Future studies should compare two systems rather than telehealth against usual care in order to mitigate against this issue [13].

Within the time available, it was not possible to conduct detailed critical appraisals of the studies located, this overview is therefore limited in that it relies on the authors findings and conclusions, rather than providing an unbiased judgement on the quality of each study. Limiting the overview to systematic reviews also means that some of the more recent studies may not have been included due to delays in the publishing process. A separate list of the most recent studies whose results may not be included has been located in Appendix 3. Furthermore there are many local evaluations of telehealth which may have been available outside the published literature. No attempt was made to locate or include these in this review.

Conclusions

Telehealth is seen as a way of improving access to patient care for long term conditions and there is a considerable volume of published literature available. This

report provides an overview of the best available evidence by summarising recent systematic reviews.

There is more evidence for some conditions than others, but on the whole the trends are largely positive suggesting that telehealth is effective in:

- Reducing patient mortality and hospital admissions for chronic heart failure
- Reducing hospital admissions for COPD
- Reducing blood pressure in hypertension, improving glycaemic control in diabetes and reducing symptoms in asthma

Furthermore for a wide range of other clinical outcomes and across conditions, telehealth seems to be as good as usual patient care, suggesting that it is fulfilling its promise of increasing access to services.

Patients appear to be satisfied with telehealth services across a wide range of conditions, although there may be a need for considering individual patient requirements in some contexts.

These conclusions are broadly in line with the early results from the large Whole Systems Demonstrator project [4] noted in the introduction and suggest that these are potentially more generalisable.

However the debate regarding the quality and nature of evaluations of telehealth systems cannot be ignored, as repeated systematic reviews have commented on the quality of evaluations. In-depth studies of patients' experiences have provided an insight into the organizational and professional factors involved in implementing telehealth systems. Examining these factors more carefully may help implement telehealth systems from all stakeholders perspectives evaluations which incorporate mixed methods or a realist approach to examine what works for whom and why, may well provide the way forward in examining in more depth the more meaningful effects of telehealthcare.

Author	Year	Condition	Mortality	Readmissions	Bed days	A&E visits	Visits to GP
Abudagga, et al	2010	Coronary	Not Assessed	Not assessed	Not Assessed	Not Assessed	**Neutral**. Office visits frequency did not change
Anker, et al	2011	Coronary	**Neutral.** Meta analysis shows a RR=0.66. More recent studies not included in any meta-analysis showed no significant differences	**Down.** Meta-analysis showed a reduction in CHF admissions. RR= 0.79 More recent (not in meta-analysis) non-invasive RCTs showed no significant difference and 1 invasive trial demonstrated a significant reduction in admissions in the TM group.	**Down.** 1 RCT concluded that the duration of hospital stays was reduced compared to the usual care. (9.1 vs 3.8 days)	Not Assessed	Not assessed
Bolton, et al	2011	COPD	**Neutral.** 1/6 studies assessed and found no change.	**Down.** 4/6 studies found reduction in admission. Unclear as to the cause of the admission	Not Assessed	Not Assessed	Not Assessed
Clarke et al	2011	Coronary	**Down. O**verall risk ratio 0.77.	**Neutral**. No change in all cause admission RR=0.99. Drop in CHF admission RR=0.73 in the TM group. Over time the intervention had no effect on admissions.	**Neutral**. 7/9 studies reported no change. 2/9 reported reduction. No meta-analysis	**Neutral.** RR=1.04	Not Assessed
de Waure, et al	2012	Coronary	**Down.** In-hospital mortality reduced 35%. One study reported all cause mortality, not just due to MI. 2 studies reported 12 month survival in which mortality more than halved.	Not Assessed	Not Assessed	Not assessed	Not Assessed
Inglis, et al	2011	Coronary	**Down.** 34% reduction in risk of mortality with TM.	**Down.** TM reduced CHF hospitalisations by 21%	**Neutral.** No reported change with TM	Not assessed	Not assessed
McLean, et al	2011	COPD	**Neutral.** Insignificant change in odds ratio (1.05 p=0.86)	**Down.** Odds ratio of 0.46 compared to control. Likewise a lower odds of being discharged to a higher level of care (OR:0.29).	Not Assessed	**Down.** Meta-analysis Less likely to attend emergency dep't than control (odds ratio:0.27). Additional studies also demonstrated that control group patients are more likely to attend. Conversely one study reported a greater average visits	Not Assessed

						by the intervention (1.79) than the control (1.53).	
Pare et al	2010	Diabetes, Asthma, Hypertension, Heart Failure	**Neutral.** Heart failure studies were equivocal and mortality didn't differ between control and intervention groups	**Neutral.** Heart failure studies were equivocal and no statistical differences were found between intervention and control groups	Not Assessed	Not Assessed	Not Assessed
Polisena, et al	2010	Coronary	**Down.** All deaths RR=0.64. RCTs only RR=0.60	**Down.** All cause hospitalisations RR=0.77 RCTs only RR=0.79. Due to substantial heterogeneity there was no meta-analysis on total hospitalisation, the majority reported reduced hospitalisation in the TM condition. Specific to CHF, 2 studies found the TM group had increased hospitalisation where as 2 studies concluded the opposite.	**Down.** Reduced bed days in the majority of studies in the TM group compared to control. Pre-post studies showed reduced bed day post intervention. One study reported increase in bed days in the TM compared to control. Specific to CHF TM resulted in reduced bed days.	**Down.** No meta-analysis. Reduced emergency visits in the TM group compared to the control. Likewise reduced visits pre compared to post TM intervention. One study however found the TM group had higher admission than the control and one study found no difference.	**Neutral.** Outpatient visits 2 studies concluded that TM reduced visits where as two concluded the opposite.
Polisena, et al	2010	COPD	Not Assessed	**Down.** Home telemonitoring had fewer hospital admissions than those in usual care groups. Telesupport also reported lower hospitalisations.	**Neutral**. 1 observational study reported more bed days in the home telemonitoring than usual care4. 2 observations studies reported reduced bed days compared to usual care. Only one study reported a p value.	**Down.** 1 study reported a lower number of admission post TM intervention.	**Up.** One observational study found greater mean GP visits. Again no p value One observational study reported lower mean home visits compared to usual care . No p value reported.

Table 2: Clinical Outcomes

Neutral = outcome was reported in the review but no statistical difference was found between the interventions, ie the effects were the same usually between the intervention and usual care. Alternatively there were conflicting results between studies with some reporting positive effects and some no change or negative.
Up/Down = outcome was reported in the review, a statistical difference was reported.
Not Assessed = review didn't examine this outcome

Author	Year	Condition	Clinical outcome measures	QOL	Other outcome measure	Other outcome measure
Abudagga, et al	2010	Coronary	**Down**. Reduced systolic and diastolic BP. 4 studies used 24-h ambulatory BP monitoring (ABPM)and reductions were statistically significant (SBP ranging from 2.8 to 11.9mm Hg and DBP from 2.0 to 6.6mm Hg). For office-based readings, BP was reduced at a statistically significant level across these studies, with declines ranging from 3.9 to 13.0mm Hg for SBP and from 2.0 to 8.0mm Hg for DBP	**Neutral**. Quality of life did not change in 3/4 studies	None Assessed	
Bolton, et al	2011	COPD	**Down.** Excaberations:2/4 reported and were statistically significantly reduced.	**Neutral.** Quality of Life; 1/2 reported significant improvement in TM group		
Clarke, et al	2011	Coronary	Not Assessed	**Up**. Quality of life. Scores increased in the TM group. Only one study did not report a improvement of quality of life.	**Down.** Cost 4/6 studies reported decreased costs	**Neutral.** Medication adherence. 2/3 no difference. 1/3 improved adherence**.**
Holtz, et al	2012	Diabetes	**Down.** HbA1c improved in 85% of cases measured. Only 3 studies significant differences	**Neutral.** BMI no change	**Neutral.** Self efficacy: no change	**Up.** Knowledge improved in 2 studies
Inglis, et al	2011	Coronary	Not Assessed	**Up.** Three TM studies reported an improved quality of life.	**Down.** Cost decreased in 2/3 studies	
Mc Clean, et al	2011	Asthma	**Neutral.** No significant changes in FEV1 or FVC.	Not Assessed		
Omboni & Guarda	2011	Hypertension	**Down.** Ambulatory and office systolic Bp decreased in TM group compared to control; office Diastolic BP decreased in TM compared to control. Ambulatory Diastolic BP did not vary between TM and control groups. There was a greater improvement in the TM group regarding BP normalisation.	**Up.** Increase in antihypertensive drugs in TM group		
Pare, et al	2010	Diabetes, Asthma, Hypertension, Heart Failure	**Up.** Diabetes: trend towards better glycaemic control. Asthma significant improvement in PEF, significant reductions in symptoms, improvement in perceived qol. Hypertension - better control of blood pressure.	Not Assessed		
Polisena, et al	2010	Coronary	Not Assessed	**Neutral.** Quality of life: 7 studies reported no difference in QoL. 5 studies reported increased QoL and satisfaction in the interventions		
Polisena, et al	2010	COPD	Not Assessed	**Neutral.** Quality of life: 2 studies reported no difference in QoL. 2 studies reported increased QoL and satisfaction in the interventions		

Table 3: Condition specific outcomes and quality of life

Author	Title	Year	Aims	Findings
Ando et al	Feasibility Evaluation of a remote monitoring system for implantable cardiac devices in Japan. A prospective analysis	2010	To analyse the acceptance of cardiac device remote monitoring in Japan	More than 87% of the subjects felt the Monitor was easy to use, the majority felt reassured by having their devices monitored, and preferred the decreased clinic visits. Nearly all the physicians were satisfied with the system. However the Japanese context may be different than the UK.
Jones et al	Patients' experiences of self-monitoring blood pressure and self-titration of medication; the TASMINH2 trial qualitative study	2012	To explore patients views of self-monitoring blood pressure and self-titration of anti-hypertensive medication.	Patients were confident about self-monitoring and many felt their multiple home readings were more valid than a single reading taken by their GP. Although some patients were confident to adjust their medication based on results, many lacked the confidence without a consultation with their GP, especially if results were borderline. Many planned to continue self-monitoring but few wished to continue self-management plan.
Martínez-Sarriegui I, et al	How Continuous Monitoring Changes the Interaction of Patients with a Mobile Telemedicine System	2011	To analyse patients' behaviour from the use-of-the-system point of view, identifying how system monitoring may change the interaction of patients with the mobile telemedicine system.	Subjective evaluation showed that patients would recommend the DIABTel in routine care. The use of a glucose monitor changes the way that patients manage their diabetes. Continuous monitoring also increases the interaction of patients with the information system and modifies their pattern of use. Mobile technologies are especially useful where close monitoring of diabetes in necessary. They are well accepted by patients.

Rogers A, Kirk S, Gately C, May C.R, Finch T	Established users and the making of telecare work in long term condition management	2011	To illuminate how people experience, understand and negotiate the transfer of technologies into their homes. b) To examine the extent to which telecare systems are incorporated into the life world of patients and carers and the factors that promote or inhibit integration.	This robust research suggests that, telecare services provide both an adequate substitution for traditional services and additional benefits such as minimising the need to travel and the added reassurance of regular external surveillance. However, the nature of patient work involved is 'low level' rather than requiring higher level interpretation of readings and decision making commensurate with realising a policy vision of more independent and responsible self managers. Indeed a paradox of the reliance and acceptance of telecare is the creation of new relationships and dependencies rather than the diminution of reliance envisaged by policy.
Seto E , Leonard K.J, Cafazzo J.A, Barnsley J, Masino C and Ross H.J	Perceptions and Experiences of Heart Failure Patients and Clinicians on the Use of Mobile Phone-Based Telemonitoring	2012	To provide in-depth insight into the effects of telemonitoring on self-care and clinical management, and to determine the features that enable successful heart failure telemonitoring.	1) Improved patient self-care 2) Ptns more aware of condition, less anxious and more empowered 3) More effective monitoring of condition by clinicians 4) Clinical concerns re. on-going costs of telemedicine system 5) Clinical concerns re. increased workload 6) Few patients didn't want to be monitored long term whilst a few worried regarding dependency on the system.

Table 4: Qualitative studies of patient experience

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Appendix One: Search strategies

MEDLINE – OVID. Conducted 2 October 2012

1. exp Telemedicine/

2. telehealth*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]

3. 1 or 2

4. Chronic Disease/

5. Long-Term Care/

6. Self Care/

7. Disease Management/

8. Community Health Nursing/

9. long term condition*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]

10. exp Diabetes Mellitus/

11. exp Pulmonary Disease, Chronic Obstructive/

12. exp cardiovascular diseases/ or heart failure/

13. exp Kidney Diseases/

14. exp Renal Replacement Therapy/

15. exp Asthma/

16. exp Dementia/

17. exp cerebrovascular disorders/ or stroke/

18. exp Nervous System Diseases/

19. cystic fibrosis/ or exp respiratory tract diseases/ or exp cardiovascular diseases/

20. 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

21. 3 and 20

22. limit 21 to yr="2000 -Current"

23. limit 22 to (english and (clinical trial, all or clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or clinical trial or comparative study or controlled clinical trial or evaluation studies or meta analysis or practice guideline or randomized controlled trial or "review" or "scientific integrity review" or validation studies))

24. exp HIV/

25. exp HIV Infections/

26. 20 or 24 or 25

27. 3 and 26

28. 22 and 23 and 27

Cinahl – EBSCO interface. Conducted 2 October 2012

0	

#	Query
S36	S19 and S34
S35	S19 and S34
S34	S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33
S33	"Respiratory diseases"
S32	(MH "Human Immunodeficiency Virus")
S31	(MH "Nervous System Diseases+")
S30	(MH "Dementia+")
S29	(MH "Kidney Diseases+")
S28	(MH "Cardiovascular Diseases+")
S27	(MH "Respiratory Tract Diseases+")
S26	(MH "Demyelinating Autoimmune Diseases, CNS")
S25	(MH "Diabetes Mellitus+")
S24	(MH "Community Health Nursing+")
S23	(MH "Disease Management")
S22	(MH "Self Care+")
S21	(MH "Long Term Care") OR "long term condition" OR

	(MH "Nursing Home Patients")
S20	(MH "Chronic Disease")
S19	(MH "Telehealth+") OR (MH "Telemedicine+")
S18	S1 and S16
S17	S1 and S16
S16	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
S15	"Respiratory diseases"
S14	(MH "Human Immunodeficiency Virus")
S13	(MH "Nervous System Diseases+")
S12	(MH "Dementia+")
S11	(MH "Kidney Diseases+")
S10	(MH "Cardiovascular Diseases+")
S9	(MH "Respiratory Tract Diseases+")
S8	(MH "Demyelinating Autoimmune Diseases, CNS")
S7	(MH "Diabetes Mellitus+")
S6	(MH "Community Health Nursing+")
S5	(MH "Disease Management")
S4	(MH "Self Care+")
S3	(MH "Long Term

	Care") OR "long term condition" OR (MH "Nursing Home Patients")
S2	(MH "Chronic Disease")
S1	(MH "Telehealth+") OR (MH "Telemedicine+")

Health Services Management Consortium Database (HMIC). Conducted 2 October 2012

1. telehealth/ or telemedicine/ or medical telemetering equipment/ or telecare/ or telemetry/
2. "chronic disease AND/OR Chronic illness"/
3. long term care/ or long term care charters/ or exp chronic disease/ or exp chronic illness/

4."chronic disease AND/OR Chronic illness"/

5. long term treatment/
6. exp Self care/
7. exp Disease management/
8. community health care/ or community mental health care/ or community nursing/

9.exp Diabetes/

10. exp respiratory tract diseases/
11. exp cardiovascular diseases/
12. exp urologic diseases/
13. exp asthma/
14. exp nervous system diseases/
15. vascular diseases/ or stroke/
16. hiv/
17. 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
18. 1 and 17

limit 18 to yr="2000 - 2013

Web of Knowledge. Conducted 5 October 2012

Topic = (telehealth* OR telemedicine*) AND Topic=((chronic disease* OR long term care OR self care OR disease manage* OR community health nurs* OR long term condit* OR diabetes* OR pulmonary dis* OR COPD OR cardiovascular OR heart failure OR kidney OR renal OR asthma* OR dementia OR cerebrovascular OR stroke OR nervous system OR cystic fibrosis OR respiratory tract OR HIV))
Refined by: Document Types=(CLINICAL TRIAL OR REVIEW)
Time span=2000-2012.
Search language=Auto Lemmatization=On

NHS Evidence. Conducted 5 October 2012
telehealth* OR telemedicine*

Appendix Two – Overview Table

Author	Title	Year	Source	Aims/objectives of paper	Number of studies in review	Length of studies in review	Key findings
Abudagga, A., Resnick, H.E. & Alwan, M.	Impact on Blood Pressure Telemonitoring on Hypertension Outcomes: A literature review	2010	Telemedicine and e-Health	Explore the effectiveness of BP telemonitoring on BP control and other outcomes targeting patients with hypertension as a primary diagnosis	15	2-24 months	Telemonitoring resulted in a reduction of BP in all but 2 studies (13/15). Systolic BP declined by 3.9- 13mm Hg and diastolic declined by between 2 - 8 mmHg. Compliance with telemonitoring was good among patients but less well documented in healthcare providers. .
Anker, S.D., Koehler, F., & Abraham, W.T.	Telemedicine and remote management of patients with heart failure.	2011	Lancet	Summarise the available telemedicine interventions in heart failure. Discus the systematic differences between reported trials and suggest a classification system for trials of TM and remote management.	4 meta-analyses, 4 RCTs	Not stated	This paper summarises recent meta-analyses in which the outcome measures of admission and death were reduced following telemonitoring. The paper presents recent RCTs that offer findings suggesting no differences apart from one invasive study in which admissions and length of stay was reduced.
Bolton, C.E., Waters, C.S., Peirce, S., & Elwyn, G.	Insufficient evidence of benefit; a systematic review of home telemonitoring for coped	2011	Journal of Evaluation in Clinical Practice	Examine the evidence of Tm for patients with COPD.	6	3-12 months	Positive results of TM in managing COPD. However due to the risk of bias in the design of studies the conclusion is that the benefit of TM in managing COPD is not yet proven and further work is required.
Clarke, M, Shah, A., & Sharma, U.	Systematic review of studies on telemonitoring of patients with congestive heart failure: a meta-analysis	2011	Journal of telemedicine and telecare	Evaluate the effectiveness of telemonitoring on patients with congestive heart failure	13	3-15 months	There was an overall reduction in all cause mortality. There was no reduction in all cause admission although a reduction in CHF admission. There was no difference in length of stay, medication adherence or cost. Telemonitoring in conjunction with nurse home visits and specialising unit support can be effective in the management of CHF patients to improve quality of life.
de Waure, C., Caeddu, C., Gualano, M.R., Ricciardi, W.	Telemedicine for the reduction of myocardial	2012	Telemedicine and e-Health	Assess how telemedicine systems including early telemetry of ECG can improve	5	Not stated	All studies demonstrated the effectiveness of TM. 3 studies suitable for meta-analysis showed that relative risk for in-hospital mortality was 0.65 in the TM group.

	infarction mortality: A systematic review and a meta-analysis of publishes studies			health outcomes in patients with coronary artery disease, in particular acute myocardial infarction.			
Ekeland, A.G., Bowes, A. & Flottorp, S.	Methodologies for assessing telemedicine: A systematic review of reviews	2012	International journal of medical informatics	To summarise the methodologies used in telemedicine research, discuss knowledge gaps and recommendations and suggest methodological approaches for future research	21 reviews	Not stated	One group recommended larger and more rigorously designed controlled studies to assess the impacts of telemedicine. A second group proposed standardisation of populations and/or outcome measures to reduce heterogeneity and facilitate meta-analysis. A third group recommended combining quantitative and qualitative research methods. Other groups called for naturalistic approaches including methodologies addressing mutual adaptations of services and users also politically driven action research and formative research aimed at collaboration to ensure improvement in natural settings.
Ekeland, A.G., Bowes, A. & Flottorp, S.	Effectiveness of telemedicine	2010	International Journal of Medical Informatics	To report on a review of reviews on the impacts and costs of telemedicine services	80 reviews	Not stated	80 systematic reviews were included. 21 concluded telemedicine is effective, 18 that it is promising. Emerging themes are that economic analyses are problematic, the benefits of telemedicine for patients and telemedicine is a complex intervention and has unpredictable processes. There is a need for larger studies as controlled interventions. New evaluations should focus on patients perspectives, economic analyses and ongoing collaborative achievements. Formative assessments are emerging as an area of interest.
Holtz, B & lauckner, C.	Diabetes management via mobile phones	2012	Telemedicine and E-health	Understand the most common uses and functions of mobile phones in monitoring and managing diabetes, their potential role in a clinical setting and the current state of research.	21	2wks-12 months	The studies reviewed demonstrated promise in using mobile phones to help people manage their diabetes condition effectively.
Inglis, S.C.,Clark, R. A, McAlister, F. A., Stewart, S, and Cleland, J. G. F.	Which components of heart failure programmes are effective?	2011	European Journal of Heart Failure	Review randomized controlled trials (RCTs) of Telemonitoring or Structured telephone support for all-cause mortality and all-cause and CHF-related hospitalisations in patients with CHF, as a non-invasive remote model of a specialized disease-management intervention.	14	3-18 months	A systematic review and meta-analysis of the outcomes of structured telephone support or telemonitoring as the primary component of chronic heart failure management in 8323 patients: Abridged Cochrane Review Telemonitoring and STS both appear effective interventions to improve outcomes in patients with CHF.

Kraai, I.H., Luttik, M.L.A., De Jong, R.M., Jaarsma, T., & Hillege, H.L.	Heart failure patients monitored with telemedicine: Patient satisfaction, a review of the literature	2011	Journal of Cardiac Failure	Describe the current state of the literature on patient satisfaction with non-invasive telemedicine, regarding definition, measurement and overall level of patient satisfaction with telemedicine.	14	Not stated	Patients seem to be satisfied or very satisfied with the use of telemedicine. Measurement of patient satisfaction is still underexposed in telemedicine research and the measurement is under appreciated with poorly constructed questionnaires.
McLean et al McLean S, Chandler D, Nurmatov U, Liu J, Pagliari C, Car J, Sheikh A.	Telehealthcare for asthma: a Cochrane review Telehealthcare for Asthma (intervention review)	2011 2010	Canadian Medical Association Journal The Cochrane Library	A systematic review of studies of telehealthcare interventions used for the treatment of asthma to determine whether such approaches to care are effective.	21	3-12 months	We found no evidence of a clinically important impact on patients' quality of life nor A&E visits, but telehealthcare interventions do appear to have the potential to reduce the risk of admission to hospital, particularly for patients with severe asthma. Further research is required to clarify the cost -effectiveness of models of care based on telehealthcare. Significant reduction in hospital admissions, especially in patients with severe asthma. No improvement in quality of life, and no reduction in A&E admissions
McLean, S. Nurmatov, U, Liu, JLY, Pagliari, C. Car, J., & Sheikh, A.	Telehealthcare for chronic obstructive pulmonary disease (review)	2011	Cochrane database for systematic reviews	Review the effectiveness of telehealthcare for COPD compared with face to face care	10	Not stated	Increased quality of life. Reduction in attendances to emergency departments. There was no difference in the odds ratio for deaths compared to usual care.
MCLean, S., Protti, D., Sheikh, A.	Telehealthcare for long term conditions	2011	BMJ	Clinical review of telehealthcare for long term conditions: clinical relevance and application of the findings	Not stated	Not stated	Overview paper based on reviews stated above. In patients with severe long term conditions such as problematic asthma and diabetes, telehealthcare can reduce hospital admissions without increasing mortality. Potential pitfalls include: user interface problems, technical problems, and safety concerns such as data loss and confidentiality. May alter doctor-patient relationship - thus healthcare professionals need to try and humanise the interaction. Careful assessment of effectiveness, cost-effectiveness and safety consideration is needed before introducing into any practice.
Omboni, S & Guarda, A.	Impact of Home blood pressure telemonitoring and blood pressure: a meta-analysis or randomized controlled trials	2011	American Journal of Hypertension	Summarise the effectiveness of home telemonitoring on blood pressure control from randomised controlled studies.	10	2-240 weeks	Home blood pressure telemonitoring may represent a useful tool to improve blood pressure control. Heterogeneity of published studies suggest a need for more large scale RCTs to demonstrate the usefulness.
Pare et al	Clinical effects of home telemonitoring	2010	Journal of Medical Internet	To conduct a systematic review to understand the clinical effects	62	Not stated	1. Studies for diabetes showed a trend towards achieving better glycemic control with telemonitoring. 2. Studies for asthma showed significant improvements in peak expiratory flows, significant reductions in symptoms and

	in the context of diabetes, asthma, heart falure and hypertension: a systematic review		research	associated with home telemonitoring programs in the context of 4 chronic diseases.			improvements in perceived qol. Hypertension studies showed for the majority that home telemonitoring reduced systolic and or/diasistolic blood pressure. Findings for patients with heart failure were equivacol and larger trials are needed. Future studies need a better means of controlling mediating variables. Suggests a range of critical success factors when using telehealth applications. Telehealth doesn't appear to be suited to everyone, beneficial effects are mainly amongst patients whose health condition appears serious and the patients are keen to play an active role in the management of their illness or where the patients are interested in using this kind of system. The user friendliness of the device are an important acceptance criteria for patients and different types of systems a
Polisena, J., Tran, K. Cimon, K. Brian, H. McGill, S. Palmer, K., & Scott, R.E	Home telemonitoring for congestive heart failure: a systematic review and meta-analysis.	2010	Journal of telemedicine and telecare	Evaluate the effectiveness of telemonitoring on patients with congestive heart failure	22	1-12 months	Home telemonitoring reduced mortality compared to usual care. Several studies suggested that home monitoring helped lower hospitalisations. Quality of life was similar or better that without no TM. More studies of better quality are required.
Polisena, J., Tran, K. Cimon, K. Brian, H. McGill, S. Palmer, K., & Scott, R.E	Home Telehealth fo chronic obstructive pulmonary disease: a Systematic review and meta analysis.	2010	Journal of telemedicine and telecare	Compare home telehealth for COPD with usual care.	10	3-12 months	Home telehealth was found to reduce rates of hospitalisation and emergency department visits. Bed days varied. Mortality rate was greater in the telephone support group compared to usual care . Home telehealth interventions were similar or better than usual care for quality of life and patient satisfaction.
Wootton	Twenty years of telemedicine in chronic disease management: an evidence synthesis	2012	Journal of Telemedicine and Telecare	To provide a high level view of the value of telemedicine in the management of 5 common chronic diseases (asthma, COPD, diabetes, heart failure, hypertension)	141	Not stated	108 studies show positive effects whilst only 2 show negative effects, suggesting an element of publication bias. There appears to be no significant difference between the diseases, ie telemedicine is equally effective (or ineffective) for all the diseases studied. Half the systematic reviews reported showed significantly better outcomes than control and other half showed no difference. Earlier studies tend to be more positive. Most studies have a short term follow up (6 months) which is unlikely to be useful when studying a long term chronic disease. Suggests the evidence based for the value of telemedicine in chronic diseases is weak and contradictory. Suggests that most studies of telemedicine report positive effect due to the Hawthorne effect. Suggests the need for a minimum data set for future studies so that comparisons can be made.

Appendix 3 – Recent trials not covered in previous systematic reviews

1. Antonicelli, R., et al., *Impact of home patient telemonitoring on use of beta-blockers in congestive heart failure.* Drugs & Aging, 2010. **27**(10): p. 801-5.
2. Bernocchi, P., et al., *Six-month programme on lifestyle changes in primary cardiovascular prevention: a telemedicine pilot study.* European Journal of Cardiovascular Prevention & Rehabilitation, 2011. **18**(3): p. 481-7.
3. Carter, E.L., G. Nunlee-Bland, and C. Callender, *A patient-centric, provider-assisted diabetes telehealth self-management intervention for urban minorities.* Perspectives in Health Information Management, 2011. **8**: p. 1b.
4. Charpentier, G., et al., *The Diabeo software enabling individualized insulin dose adjustments combined with telemedicine support improves HbA1c in poorly controlled type 1 diabetic patients: a 6-month, randomized, open-label, parallel-group, multicenter trial (TeleDiab 1 Study).* Diabetes Care, 2011. **34**(3): p. 533-9.
5. Chaudhry, S.I., et al., *Telemonitoring in patients with heart failure.[Erratum appears in N Engl J Med. 2011 Feb 3;364(5):490].* New England Journal of Medicine, 2010. **363**(24): p. 2301-9.
6. Christensen, H., et al. *Home management of oral anticoagulation via telemedicine versus conventional hospital-based treatment*. Telemedicine journal and e-health : the official journal of the American Telemedicine Association, 2011. 169-76 DOI: 10.1089/tmj.2010.0128.
7. De, R., et al., *Early detection of adverse events with daily remote monitoring versus quarterly standard follow-up program in patients with crt-d.* Pacing & Clinical Electrophysiology, 2011. **34**(2): p. 208-216.
8. Delaney, C. and B. Apostolidis, *Pilot testing of a multicomponent home care intervention for older adults with heart failure: an academic clinical partnership.* Journal of Cardiovascular Nursing, 2010. **25**(5): p. E27-40.
9. Deschildre, A., et al., *Home telemonitoring (forced expiratory volume in 1 s) in children with severe asthma does not reduce exacerbations.* European Respiratory Journal, 2012. **39**(2): p. 290-6.
10. Domingo, M., et al., *Noninvasive Remote Telemonitoring for Ambulatory Patients With Heart Failure: Effect on Number of Hospitalizations, Days in Hospital, and Quality of Life. CARME (CAtalan Remote Management Evaluation) Study.* Revista Espanola De Cardiologia, 2011. **64**(4): p. 277-285.
11. Gellis, Z.D., et al., *Outcomes of a telehealth intervention for homebound older adults with heart or chronic respiratory failure: a randomized controlled trial.* Gerontologist, 2012. **52**(4): p. 541-52.
12. Koehler, F., et al., *Impact of Remote Telemedical Management on Mortality and Hospitalizations in Ambulatory Patients With Chronic Heart Failure The Telemedical Interventional Monitoring in Heart Failure Study.* Circulation, 2011. **123**(17): p. 1873-1880.
13. Kroenke, K., et al. *Effect of telecare management on pain and depression in patients with cancer: a randomized trial*. JAMA : the journal of the American Medical Association, 2010. 163-71 DOI: 10.1001/jama.2010.944.
14. Landolina, M., et al., *Remote monitoring reduces healthcare use and improves quality of care in heart failure patients with implantable defibrillators:*

the evolution of management strategies of heart failure patients with implantable defibrillators (EVOLVO) study. Circulation, 2012. **125**(24): p. 2985-92.
15. Magid, D.J., et al., *A multimodal blood pressure control intervention in 3 healthcare systems.* American Journal of Managed Care, 2011. **17**(4): p. e96-103.
16. McManus, R.J., et al., *Telemonitoring and self-management in the control of hypertension (TASMINH2): a randomised controlled trial.* Lancet, 2010. **376**(9736): p. 163-172.
17. Seto, E., et al., *Mobile phone-based telemonitoring for heart failure management: a randomized controlled trial.* Journal of Medical Internet Research, 2012. **14**(1): p. e31.
18. Shah, B.R., et al., *Secondary prevention risk interventions via telemedicine and tailored patient education (SPRITE): a randomized trial to improve postmyocardial infarction management.* Circulation. Cardiovascular Quality & Outcomes, 2011. **4**(2): p. 235-42.
19. Sparrow, D., et al., *A telemedicine intervention to improve adherence to continuous positive airway pressure: a randomised controlled trial.* Thorax, 2010. **65**(12): p. 1061-6.
20. Steventon, A., et al., *Effect of telehealth on use of secondary care and mortality: findings from the Whole System Demonstrator cluster randomised trial.* BMJ: British Medical Journal (Overseas & Retired Doctors Edition), 2012. **345**(7865): p. 16-16.
21. Stone, R.A., et al., *Active care management supported by home telemonitoring in veterans with type 2 diabetes: the DiaTel randomized controlled trial.* Diabetes Care, 2010. **33**(3): p. 478-84.
22. Takahashi, P.Y., et al., *A randomized controlled trial of telemonitoring in older adults with multiple chronic conditions: the Tele-ERA study.* BMC Health Services Research, 2010. **10**: p. 255.
23. Tompkins, C. and J. Orwat, *A Randomized Trial of Telemonitoring Heart Failure Patients.* Journal of Healthcare Management, 2010. **55**(5): p. 312-322.
24. Weinstock, R.S., et al., *Glycemic control and health disparities in older ethnically diverse underserved adults with diabetes: five-year results from the Informatics for Diabetes Education and Telemedicine (IDEATel) study.* Diabetes Care, 2011. **34**(2): p. 274-9.

Glossary and explanation of terms:

Some of the common terms and techniques which are used throughout this report are explained below.

Systematic review = a rigorous review of primary research studies on a particular topic area. The methods used to conduct the review are made explicit and the papers included are examined in an unbiased way according to a set of pre-established criteria. Viewed as the "gold standard" means of providing the best evidence available.

Meta-analysis = Technique which statistically combines the outcomes of multiple studies to show the effect of an intervention. Often used in conjunction with systematic reviews. Overcomes problems with small sample sizes but can only be conducted with studies with comparable outcomes. Because many of the studies within the reviews included here were very different and compared different outcomes, some reviews have not included meta-analyses or only conducted meta-analyses on a limited number of outcomes.

RR=Risk ratio or relative risk. A method of comparing outcomes between an intervention and control group to demonstrate whether an intervention has had an effect (or not). If the intervention and control conditions have the same effect, then (assuming the groups are comparable in all other respects) the risk of the event (eg, death) will be the same in both groups, and the RR will be 1.0. If the risk of death is reduced in the intervention group compared with the control group, then the RR will be less than<1.0. If, however, the intervention is harmful, then the RR will be greater than >1.0. The further away the RR is from 1.0, the greater the strength of the association between the intervention and the outcome.

OR = Odds ratio. An alternative method of comparing outcomes between an intervention and control group based on odds or probabilty. An OR of 1.0 means there is no difference between the groups and an OR less than <1.0 means that the event is less likely in the intervention group than the control group.

Both risk ratios and odds ratios assess statistical significance rather than actual clinical significance, ie they demonstrate relative differences rather than the actual effect in clinical terms.

Relative and absolute differences in risk can each be expressed in 4 different ways, depending on the outcome measured ("good" event or "bad" event) and the direction of effect. A risk reduction occurs when the risk of a bad event decreases. A benefit increase occurs when the risk of a good event increases. A risk increase occurs when the risk of a bad event increases, and a benefit reduction occurs when the risk of a good event decreases.

RCT – Randomised controlled trial. An experimental study which compares two or more interventions in an unbiased way. Viewed as the gold standard method of assessing effectiveness of an intervention. However not always feasible to conduct when an intervention has lots of variables which need to be controlled or operates in multiple contexts.

University of Salford MANCHESTER

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