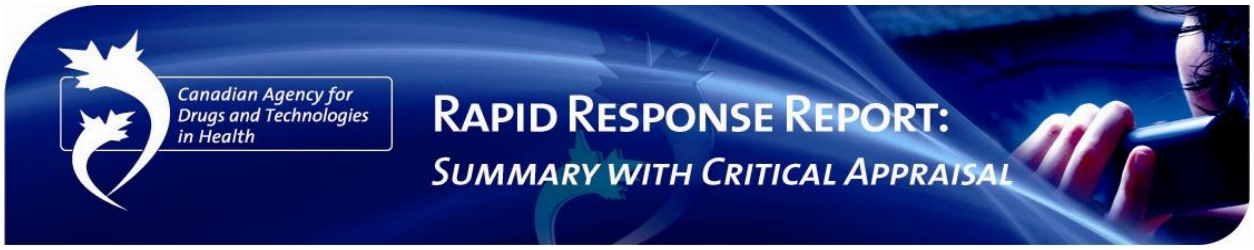

TITLE: Telehealth for Patients with Hypertension, Coronary Artery Disease or Implantable Cardiac Devices: A Review of the Clinical Effectiveness, Cost-effectiveness and Guidelines

DATE: 27 January 2016

CONTEXT AND POLICY ISSUES

Hypertension (or high blood pressure), coronary artery disease (CAD) and cardiac conditions requiring implantable cardiac devices (such as pacemakers, cardioverter-defibrillators, and cardiac resynchronization devices) are the leading causes of mortality and morbidity worldwide, with cardiovascular diseases responsible for 30% of worldwide mortality[1] and hypertension alone contributing to 7.6 million premature deaths each year.[2]

The management of hypertension, CAD, and patients with implantable cardiac devices requires continuous care, and extends to professional services delivered to patients' home via some form of telehealth technology with the aim to keep patients well and reduce unnecessary hospital admissions.[3,4] Telehealth is a broad term used to describe a range of communication and information technologies that aim to provide professional health care advice and services from a distance.[5,6] Telehealth may include telecommunications technologies such as the internet, telephone, or videoconferencing to transmit physiological data from the patient to health care professionals, structured telephone support, and telemonitoring using a monitor device with digital, broadband, satellite, wireless, or blue-tooth transmission.[7] In Canada, with an increase in the aging population, there may be a greater need for remote patient monitoring due to an increase in chronic conditions.[8]

A previous Rapid Response report reviewed the evidence for the use of telehealth for patients with heart failure.[9] In general, the use of telehealth such as structured telephone support or home telemonitoring using telecommunications technologies contributed to reductions in hospitalizations and mortality, and improved quality of life and lifestyle behavior in patients with heart failure. A limited amount of evidence on cost-effectiveness showed inconsistent findings on the cost-effectiveness of telehealth compared to usual care for patients with heart failure. In Canada, the use of a Health Lines intervention (nurses available on telephone to provide suggestions) may be more cost-effective than usual care.

This Rapid Response report aims to review the clinical- and cost-effectiveness of telehealth for patients with hypertension, CAD, or conditions requiring implantable cardiac devices. Guidelines associated with the use of telehealth in the management of these conditions will also be examined.

RESEARCH QUESTIONS

1. What is the clinical evidence regarding telehealth interventions for patients with hypertension, coronary artery disease (CAD), or implantable cardiac devices requiring cardiac care?

2. What is the cost-effectiveness of telehealth interventions for patients with hypertension, CAD, or implantable cardiac devices requiring cardiac care?

3. What are the evidence-based guidelines regarding telehealth interventions for patients with hypertension, CAD, or implantable cardiac devices requiring cardiac care?

KEY FINDINGS

Telemonitoring of blood pressure costs more than usual care, but it may represent an useful tool for hypertension control by improving blood pressure and increasing the chances for patients to achieve blood pressure normalization. There was no evidence available on the cost-effectiveness of telemonitoring in patients with CAD requiring cardiac rehabilitation, but telehealth interventions do not have inferior outcomes compared to center-based supervised programs, and telephone support may reduce hospitalizations and reduce risk factors for heart disease. For patients with heart diseases requiring implantable cardiac devices, the costs of telemonitoring were lower than conventional hospital monitoring. Pacemaker telemonitoring led to earlier cardiovascular event detection, with a reduction in hospital visits and hospitalizations. Telemonitoring of implantable cardioverter-defibrillators had similar outcomes compared to in-office follow-up.

A Canadian position statement recommends that remote monitoring should be available at all device follow-up clinics as an integral part of the standard of care of device patients with cardiovascular implantable electronic devices.

METHODS

Literature Search Strategy

A limited literature search was conducted on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses, economic studies, and guidelines. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2013 and November 23, 2015.

Selection Criteria and Methods

One reviewer screened the titles and abstracts of the retrieved publications and examined the full-text publications for the final article selection. Selection criteria are outlined in Table 1.

Table 1: Selection Criteria

Population	Patients with hypertension, CAD and implantable cardiac devices requiring cardiac care
Intervention	Tele-medicine interventions (e.g. Video conferencing, Home health monitoring, Tele-health phone lines, Digital medical devices [e.g. digital stethoscope]) for assessment and follow-up
Comparator	Standard care (in person consultation and/or assessment)
Outcomes	Clinical benefits or harms (improved health outcomes, improved access to care, patient experience, travel time, avoidance of transfer) Cost-effectiveness (both health care system and impact on patients/families) Guidelines for use of telemedicine (including optimal types of patients or those for whom it would not be recommended)
Study Designs	Health technology assessments (HTA), systematic reviews (SR), and meta-analyses (MA), economic evaluations, and guidelines.

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria in Table 1, if they were about heart failure (this condition is the topic of a separate Rapid Response review[9]), if they were published prior to January 2013, if they were duplicate publications of the same study, or if they were included in a selected systematic review.

Critical Appraisal of Individual Studies

The quality of the included systematic reviews, cost evaluations, and guidelines was assessed using the AMSTAR,[10] Drummond,[11] and AGREE[12] checklists, respectively. Numeric scores were not calculated. Instead, the strengths and limitations of the study are summarized and presented.

SUMMARY OF EVIDENCE

Quantity of Research Available

The literature search yielded 387 citations. After screening of abstracts from the literature search and from other sources, 85 potentially relevant studies were selected for full-text review. A total of twelve studies on telehealth for hypertension (4 studies), CAD (2 studies) and implantable cardiac devices (6 studies) were included in the review. The PRISMA flowchart in Appendix 1 details the process of the study selection.

Summary of Study Characteristics

A detailed summary of the included SRs and cost studies is provided in Appendix 2 and 3, respectively.

Study design

Five included studies are systematic reviews on clinical effectiveness of telemonitoring,[13-17] six are cost-effectiveness studies,[18-23] and one is a guideline.[24] Four systematic reviews included only RCTs,[13-15,17] and one systematic review included clinical trials and observational studies.[16] Three systematic reviews performed meta-analysis,[13,14,17] and two were narrative reviews.[15,16]

All six cost-effectiveness studies performed cost analysis and cost effectiveness evaluation.[18-23] One study used a Markov model with a sample size of 1000 patients and an amortization period of 10 years.[22]

The included guideline is a Canadian Cardiovascular Society/Canadian Heart Rhythm Society joint position statement, representing the consensus of a Canadian expert panel with a mandate to formulate disease-specific recommendations.[24]

Population

One systematic review included adult patients with hypertension,[13] with mean systolic blood pressure (SBP) of 144.9 ± 11.4 (standard deviation [SD]), and mean diastolic blood pressure (DBP) of 84.5 ± 5.7 (SD). Two systematic reviews included adult patients with CAD who needed post-discharge care following a myocardial infarction or a revascularization procedure.[14,15] Two systematic reviews included adult cardiac patients with pacemakers,[16] and implantable cardioverter-defibrillators.[17]

The cost studies included adult patients with uncontrolled blood pressure,[18-20] or adult patients with heart diseases that require implantable cardiac devices.[21-23]

The Canadian Position Statement provided recommendations on the use of remote monitoring for patients with implantable cardiovascular electronic devices.[24]

Interventions and comparators

The systematic review on hypertensive patients evaluated home blood pressure telemonitoring (manually measured and recorded by the patient or electronically transmitted to a health care provider using telemonitoring which includes telecommunications technologies such as the internet, telephone, or videoconferencing to transmit physiological data from the patient to health care professionals).[13] The systematic reviews on patients with CAD undergoing cardiac rehabilitation evaluated the effect of telephone support,[14] or telehealth intervention (such as telephone, computer, internet, and videoconferencing).[15] The systematic reviews on patients with implantable cardiac devices such as pacemakers[16] or implantable cardioverter-defibrillators[17] evaluated telemonitoring which consisted of using electronic equipment to observe and record physiological processes while patients carry out their daily activities. The comparator in all included studies was usual care where there was no telemonitoring. The definition of usual care varied across studies.

The cost studies included patients with blood pressure monitoring services,[18-20] or patients with implantable cardiac devices who require remote monitoring services.[21-23] The comparator in all included studies was usual care where there was no telemonitoring.

Outcomes

The systematic review on patients with hypertension[13] reported blood pressure changes, the proportion of patients with blood pressure normalization, adherence rate, quality of life, and costs. The systematic review on patients with CAD[14,15] reported the effects of telemonitoring blood pressure change, all-cause hospitalization, all-cause mortality, risk factor changes (blood lipids, smoking habit, weight), psychosocial status, and quality of life. The systematic reviews on patients with implantable cardiac devices[16,17] reported cardiovascular events, length of hospital stay, routine or emergency hospital visits, all-cause mortality, cardiovascular mortality and inappropriate implantable defibrillator shocks.

All six cost-effectiveness studies performed cost analyses and cost effectiveness evaluations.[18-23] Three studies calculated the incremental cost-effectiveness ratio (ICER),[18-20] and two studies calculated the extra monetary resources needed for the intervention to gain one extra life year (not quality-adjusted).[19,20] The remaining three studies reported on direct costs[21,23] or costs and consequence.[22] The time horizon was six months in two studies,[18,19] one year in three studies,[20,21,23] and the amortization period was 10 years in a study using the Markov model.[22]

Summary of Critical Appraisal

The included systematic reviews provided a priori design, had duplicate study selection and data extraction procedures in place, performed comprehensive literature searches, provided a list of included studies and study characteristics, and conducted quality assessment of the included studies which was used in formulating conclusions.[13-17] A list of excluded studies was not provided, there was no assessment of publication bias, and there was considerable heterogeneity in the interventions (different telemonitoring systems and self-monitoring programs) and demographics among the included trials, thus pooled data must be interpreted with caution.[13-17] Conflict of interest was not stated in one systematic review.[17]

The included cost studies were likely to be usable, outcomes and costs were assessed and appropriately compared, all appropriate costs were considered, sources for costs were provided, costs of alternatives and a sensitivity analysis was performed, and the presentation and discussion of study results include all issues of concern to users.[18-23] Three studies did not perform incremental analysis for cost and effectiveness.[21-23] There was a high degree of heterogeneity of costs between the included studies due to differences in costs of technologies and in social insurance systems across countries. Four studies were performed in Europe, thus limiting the generalizability of the findings to an European context.[18,21-23]

The included guideline is a Canadian position statement[24] with clear scope and purpose, specific and unambiguous recommendations, clear method for searching and selecting the evidence, clear and rigorous methods used for formulating the recommendations, and a clear definition of target users. It was unclear whether the guideline was piloted among target users, whether patients' views and preferences were sought. Potential cost implications of applying the recommendations, and a procedure for updating the guidelines were not included.

Details of the strengths and limitations of the included studies are summarized in appendix 4.

Summary of Findings

Main findings of included studies are summarized in detail in Appendix 5.

Clinical evidence of telehealth for patients with hypertension

The literature search identified one systematic review which evaluated the clinical effectiveness of home blood pressure telemonitoring (HBPT).[13] In general, HBPT may represent an useful tool for hypertension control. The systematic review/meta-analysis included 23 RCTs that evaluated the clinical effectiveness of home blood pressure telemonitoring (HBPT), compared to usual care, in adult patients with hypertension, with mean SBP of 144.9 ± 11.4 (SD), and mean DBP of 84.5 ± 5.7 (SD). HBPT was found to improve SBP and DBP, with a difference of 4.71 mmHg and 2.45 mmHg, respectively, compared to usual care. The differences were statistically significant. HBPT also increased the chances for patients to achieve office BP normalization in both diabetic and non-diabetic populations by 16% (relative risk [RR] 1.16; P < 0.001). HBPT helped improve the physical component of quality of life (SF-12 or SF-36 questionnaire: weighted mean difference [WMD] +2.78; 95% confidence interval [CI] +1.15 to +4.41; P < 0.001). There was no statistically significant difference in both intervention and usual care groups in terms of therapeutic adherence, rate of office consultations, and risk of adverse events.

Clinical evidence of telehealth for patients with CAD

The literature search identified two systematic reviews which included 26 and 15 RCTs, respectively, that evaluated the clinical effectiveness of telephone support,[14] and telehealth interventions[15] in patients with CAD requiring cardiac rehabilitation. In general, telephone support may reduce hospitalizations, with more participants who stopped smoking, had lower SBP, and lower depression scores. Telehealth interventions do not have inferior outcomes compared to center-based supervised programs.

a. Telephone support[14]

There was no statistically significant difference in all-cause mortality between the telephone group and the group receiving standard care. The intervention was associated with significantly fewer hospitalizations than the comparison group (odds ratio [OR] 0.62; 95% CI 0.40 to 0.97).

There was no statistically significant difference in low density lipoprotein between the two groups. Significantly more participants in the telephone group stopped smoking (OR 1.32; 95% CI 1.07 to 1.62) or had lower depression scores (standardized mean difference [SMD] -0.10; 95% CI -0.21 to 0.00); and lower anxiety scores (SMD -0.14; 95% CI -0.24 to -0.04).

b. Telehealth interventions (telephone, computer, internet, and videoconferencing)[15]

No statistically significant difference was found between telehealth interventions delivered and center-based supervised cardiac rehabilitation in all-cause mortality, exercise capacity, weight, SBP, DBP, total cholesterol, smoking, quality of life, or psychosocial state.

Clinical evidence of telehealth for patients with implantable cardiac devices

The literature search identified two systematic reviews which included seven studies (three clinical studies and four cost studies) and nine RCTs, respectively, that evaluated the clinical effectiveness of pacemaker,[16] and implantable cardioverter-defibrillator telemonitoring[17] in cardiac patients requiring implantable devices. In general, pacemaker telemonitoring led to earlier cardiovascular event detection, with a reduction in hospital visits and hospitalizations. Telemonitoring of implantable cardioverter-defibrillators had similar outcomes compared to in-office follow-up.

a. Pacemaker telemonitoring[16]

Cardiovascular events were detected and treated two months earlier with telemonitoring than with conventional monitoring (data from 1 study). Length of hospital stay was reduced by 34% by telemonitoring (data from 1 study). There were no significant differences in quality of life, or number of adverse events between groups (data from 1 study).

b. Implantable cardioverter-defibrillator telemonitoring[17]

There were no significant differences in all-cause and cardiovascular mortality between groups. There were no significant differences in hospitalizations between groups. Odds of receiving any implantable cardiac devices (ICD) shock were similar in telemonitoring and in-office patients. Odds of inappropriate shock were reduced by 45% in telemonitoring patients (OR 0.55; P = 0.002).

Cost-effectiveness of telehealth interventions for patients with hypertension

The literature search identified one systematic review[13] and three cost studies on the cost-effectiveness of telehealth interventions for patients with hypertension.[18-20] In general, home telemonitoring of blood pressure costs more than usual care, mainly attributable to additional encounters with health care professionals, greater hypertensive medication use, additional laboratory monitoring, and blood pressure monitoring.

The systematic review included six studies that reported economic analyses of HBPT compared to usual care in patients with hypertension.[13] Total healthcare costs (intervention operating costs plus medical costs) were significantly larger in the HBPT group (+€662.92 per patient; 95% CI +540.81 to +785.04). When only medical costs were considered, there was no statistically significant difference between HBPT and the usual care group. A cost study in the UK[18] found that total health care costs for HBPT were significantly more than usual care (+£115.32 per patient; 95% CI +83.49 to +146.63), with an ICER £25.56 per additional 1 mm Hg lowering of SBP. An US cost study[19] found that total health care costs for HBPT were significantly more than usual care (HBPT: $1590; 95% CI 934 to 2841; usual care: $1283; 95% CI 681 to 2383), with a ICER US$20.50 per additional 1 mm Hg lowering of SBP, and US$3330 per additional life year gained. Another US cost study[20] found HBPT led to an ICER US$65.29 per additional 1 mm Hg lowering of SBP, US$114.82 per additional 1 mm Hg lowering of DBP, and US$1850 for men, US$2220 for women per life-year gained (life expectancy and the impact that uncontrolled BP has on life expectancy differ by gender).

Cost-effectiveness of telehealth interventions for patients with implantable cardiac devices

The literature search identified one systematic review[16] and three cost studies[21-23] on the cost-effectiveness of telehealth interventions for patients with heart diseases requiring implantable cardiac devices. In general, the costs of telemonitoring were lower than conventional hospital monitoring.

The systematic review included seven studies on the costs of pacemaker telemonitoring systems in patients with atrioventricular block.[16] The costs of the telemonitoring group were lower than those of the conventional hospital monitoring group by almost 60% (€872.14 vs. €2162.78). If the 96 patients included in the study had had the data transmission system instead of emergency department visits, there would be a saving of €17247 over 3 years.
A cost study in Portugal on patients requiring implantable cardioversion-defibrillation and/or synchronization device[21] showed that the introduction of remote monitoring technology can reduce total follow-up costs by 25%. Telemonitoring services (2 remote appointments and 2 in-office appointments) led to a total follow-up cost of €2,276.40 after one year (appointments scheduled every 3 months), while in-office appointments (4 appointments) cost €3,052.80 (difference €776.40). A cost study from various countries in Europe on patients requiring implantable cardioversion-defibrillation and/or synchronization devices[22] found that telemonitoring is cost neutral over 10 years. This is mainly accomplished by reducing the number of battery charges and inappropriate shocks, resulting in fewer device replacements, and by reducing the number of in-clinic visits (telemonitoring: £11,452, conventional in-office visits: £11,486). A cost study in Italy on patients requiring implantable cardioversion-defibrillation and/or synchronization devices[23] found that the total hospital costs per patient per year (staff costs, equipment, technology purchase) were US$ 103 ± 27 for telemonitoring and US$ 154 ± 21 for conventional in-hospital visits (P = 0.01).

Evidence-based guidelines regarding telehealth interventions for patients with hypertension, CAD, and implantable cardiac devices

The literature search identified a Canadian position statement which provided recommendations on the use of remote monitoring for patients with cardiovascular implantable electronic devices.[24] Based on mainly low and moderate quality of evidence, this position statement recommends that remote monitoring should be available at all device follow-up clinics as an integral part of the standard of care of device patients. Details on recommendations are presented in Table A4, Appendix 5.

Limitations

One limitation in the included clinical effectiveness systematic reviews is the heterogeneity of the interventions used in the included trials and reviews. Meta-analyses pooled data from older and newer studies using different technologies without subgroup analyses based on different technologies. Included systematic reviews found inadequate reporting by many trials which precluded classification of risks of bias. The cost-effectiveness studies had limited data sample sizes and there was a high degree of heterogeneity of costs between the included studies due to differences in costs of technologies and in social insurance systems across countries. The majority of cost studies was performed in Europe, thus the generalizability of the findings to the Canadian context is limited.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Telemonitoring may represent a useful tool for hypertension control. The increase in cost for blood pressure home monitoring can be balanced by the increase in blood pressure control and the chances for patients to achieve blood pressure normalization. There was no evidence on the cost-effectiveness of telemonitoring in patients with CAD requiring cardiac rehabilitation; telehealth interventions do not appear to have inferior outcomes compared to center-based supervised programs, and telephone support may reduce hospitalizations, and reduce risk factors for heart diseases. The costs of telemonitoring were lower than conventional hospital monitoring for patients with pacemakers or implantable cardioverter-defibrillators, and pacemaker telemonitoringmay lead to earlier cardiovascular event detection, with a reduction in hospital visits and hospitalizations; telemonitoring of implantable cardioverter-defibrillators had similar outcomes compared to in-office follow-up. A Canadian position statement recommends that remote monitoring should be available at all device follow-up clinics as an integral part of the standard of care of device patientswith cardiovascular implantable electronic devices.

In addition to telehealth use, patients' training before discharge from hospital is essential, including training about heart failure and its treatment, diet, exercise, self-monitoring and self-management, and methods of connecting with health care workers by telecommunication technologies. Pre-discharge training was shown to make a positive difference in the readmission rates for patients with heart failure.[25] However, evidence for the impact on pre-discharge training for hypertension, coronary artery disease or patients with implantable cardiac devices was not identified in the literature search.

Despite evidence on the clinical effectiveness of telehealth, patients and staff acceptance of telehealth is an important but not well-studied factor, leading to a potential underuse of telehealth interventions.[26] Many patients feel that they are unable to operate monitoring devices, telemonitoring may undermine their sense of identity, and the time taken to complete daily monitoring is a barrier to adherence.[27] Many patients also believe that telemonitoring disrupts the relationship with their physician and fosters social isolation,[28,29] while factors affecting front-line staff were identified as the negative impact of service change (e.g. burden to the nursing staff), staff-patient interaction (staff commented that job satisfaction came from face-to-face contact with patients), credibility and autonomy (nurses often viewed telehealth as extra responsibility), and technical issues.[30] Successful adoption of telehealth and fruitful outcomes require an analysis of needs and education on both patients and staff.

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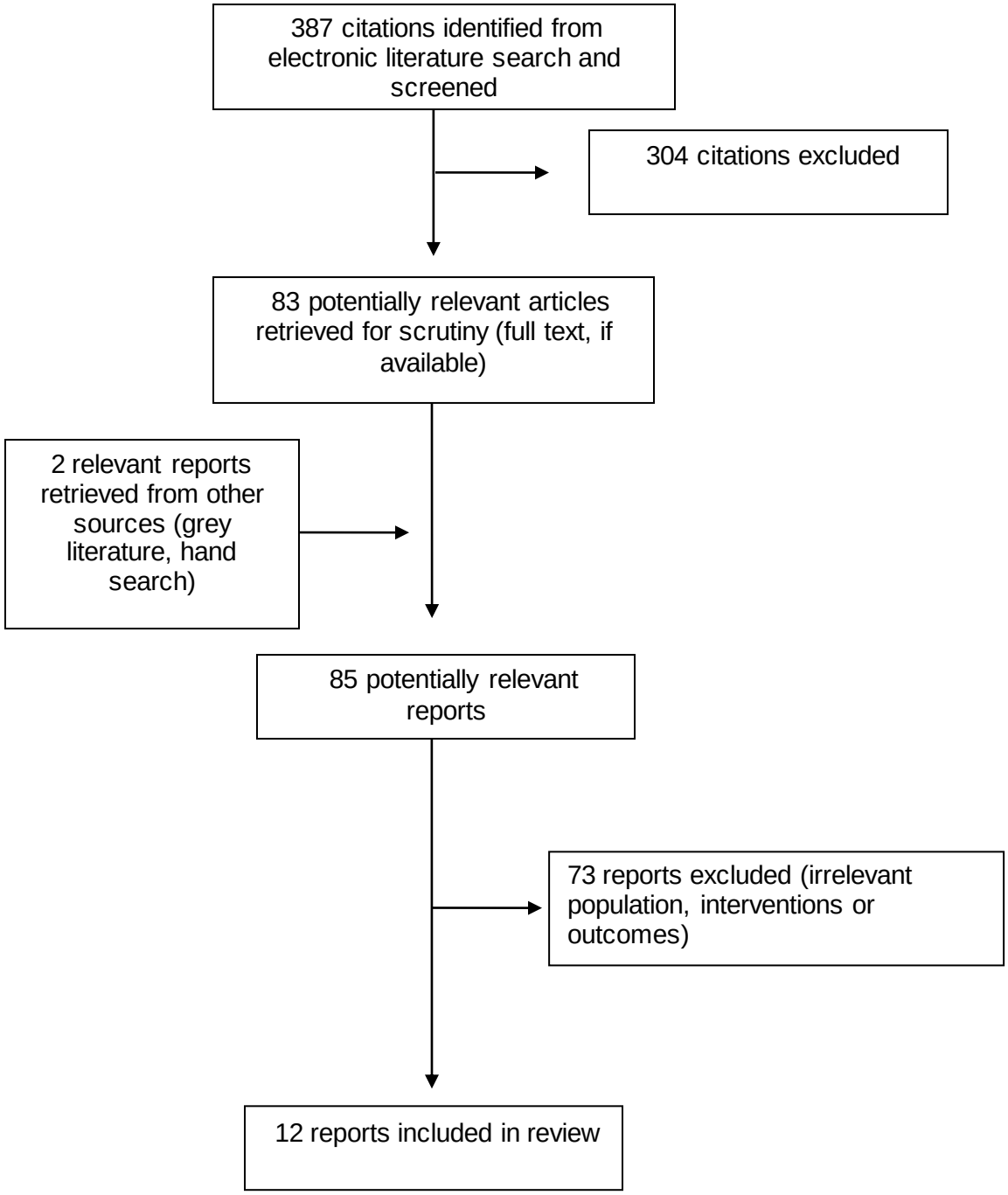
Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Systematic Reviews

Table A1: Characteristics of Included Systematic Reviews

First Author, Year, Country,	Literature Search Strategy	Inclusion Criteria	Exclusion Criteria	Studies included Main outcomes
Hypertension				
Omboni,[13] 2013, Italy	"*Electronic databases (Pubmed, Embase, Cochrane database of systematic reviews) were scanned for articles published in English language in peer-review[sic] journals from inception to February 2012.*" (p 456)	"*a randomized controlled design; the availability of an intervention group based on HBPT, and of; a control group based on usual care not including HBPM*" (p 456)	Studies that did not meet the selection criteria	23 RCTs included BP changes BP normalization Prescription of hypertensive medications Adherence Costs (intervention operating costs, medical costs)
Coronary artery diseases				
Kotb,[14] 2014, Canada	*"Relevant randomized controlled trials published before September 2012 were identified by searching the following databases: Cochrane Central Register of Controlled Trials (CENTRAL),Database of Abstracts of Reviews of Effects (DARE) and Health Technology Assessment Database (HTA) on The Cochrane Library, MEDLINE, EMBASE, CINAHL, AMED, and the Web of Knowledge. Language restrictions were not applied to any of the searches."* (p 2)	*"Randomized controlled trials were included if they directly compared the impact of telephone-delivered post-discharge interventions with standard care at discharge in adults (18 years or older) who had experienced a myocardial infarction (MI), a revascularization procedure (coronary artery bypass grafting (CABG) or percutaneous transluminal coronary angioplasty (PTCA)), and those with angina, or angiographically defined coronary heart disease."* (p 2)	Studies that did not meet the selection criteria	26 RCTs included All-cause Hospitalization All-cause mortality, depression, anxiety, smoking cessation, low-density lipoprotein cholesterol levels.

Table A1: Characteristics of Included Systematic Reviews				
First Author, Year, Country,	**Literature Search Strategy**	**Inclusion Criteria**	**Exclusion Criteria**	**Studies included Main outcomes**
Huang,[15] 2015, PR China	*"Randomized controlled trials, systematic reviews, and meta-analyses were identified by searching the following databases: Medline, Embase, Chinese BioMedical Literature Database (CBM), and the Cochrane Central Register of Controlled Trials (CENTRAL) in the Cochrane Library. The complete search strategy is available in the Supplementary Material. No time limit or language restrictions were used in the search"* (p 960)	*"(a) randomized controlled trials; (b) participants included patients with myocardial infarction, angina, or patients who had undergone revascularization (coronary artery bypass grafting, or percutaneous coronary intervention); (c) telehealth intervention delivered CR was defined as a structured community- or home-based exercise program, delivered by any kind form of following technology: telephone, computer, internet, or videoconferencing …"* (p 960)	Studies that did not meet the selection criteria	15 RCTs included All-cause mortality Risk factors (blood lipids, blood pressure, smoking, weight) Quality of life Psychosocial status
Implantable cardiac devices				
Lopez-Villegas,[16] 2015, Spain	*"The literature search was conducted on 1 December 2014, with no restrictions on language or year of publication. The databases used were MEDLINE (via PubMed), EMBASE, DARE, HTA, NHS Economic Evaluation Database (NHS EED), LILACS, IMA, CUIDEN, and the doctoral theses available on Teseo, TDR, and Dialnet."* (p 2)	*a) experimental or observational design; b) studies based on complete economic evaluations, that is, studies comparing health outcomes and costs, with no exclusions for analysis method (cost-effectiveness, cost-utility, cost-benefit, and cost-minimization); c) patients with pacemakers, and d) TM compared with HM.* (p 2)	Studies that did not meet the selection criteria	7 studies included Detection of cardiovascular events Length of hospital stay Routine and emergency hospital visits Costs (healthcare sector costs)

Table A1: Characteristics of Included Systematic Reviews				
First Author, Year, Country,	**Literature Search Strategy**	**Inclusion Criteria**	**Exclusion Criteria**	**Studies included Main outcomes**
Parthiban,[17] 2015, Australia	*"We conducted a systematic search of PubMed, Embase, Scopus, Web of Science, and the Cochrane databases to identify RCTs comparing RM with conventional IO follow-up in ICD patients. Databases were last accessed on July 30, 2014 and results were updated after the publication of the IN-TIME trial on August 16, 2014."* (p 2592)	*"RCTs were included if results were published in peer-reviewed journal articles or as published abstracts with extractable data."* (p 2592)	*"Studies were excluded if they provided outcome data only from nonrandomized cohorts or case series, evaluated ICDs but not RM, or evaluated RM in contexts other than ICD patients."* (p 2592)	9 RCTs included All-cause mortality Cardiovascular Mortality Hospitalization All implantable defibrillator shock Inappropriate shock

BP: blood pressure; CR: cardiac rehabilitation; HBPT: home blood pressure telemonitoring; IO: in-office

Appendix 3: Characteristics of Included Studies

Table A2: Characteristics of included cost studies

First Author, Year, Country,	Study Objectives	Interventions/Comparators	Patients	Main outcomes
Hypertension				
Stoddart,[18] 2013, UK	*"To compare the costs and cost effectiveness of managing patients with uncontrolled blood pressure (BP) using telemonitoring versus usual care from the perspective of the National Health Service (NHS)"* (p 1)	*"Participants were centrally randomised to 6 months of a telemonitoring service comprising of self-monitoring of BP transmitted to a secure website for review by the attending nurse/doctor and patient, with optional automated patient decision-support by text/email (n=200) or usual care (n-201)"* (p 1)	*"401 primary care patients aged 29–95 with uncontrolled daytime ambulatory blood pressure (ABP) (≥135/85, but <210/135 mm Hg)"* (p 1)	*"Mean difference in total NHS costs between trial arms and blinded assessment of mean cost per 1 mm Hg systolic BP point reduced"* (p 1) ICER
Billups,[19] 2014, US	*"To evaluate the health system cost of a home blood pressure monitoring (HBPM) program versus usual care in an integrated healthcare system"*(p e380)	*"This was a randomized, controlled study of 348 patients with uncontrolled hypertension randomly assigned to the HBPM program or usual care"*(p e381)	*"This cost-effectiveness analysis was based upon a previously completed randomized controlled trial of 348 hypertensive patients (average age 60 years), in which mean systolic blood pressure (BP) was lowered 21 versus 8 mm Hg in the HBPM and usual care groups, respectively"*(p e380)	*"Primary outcomes were the incremental hypertension care-related cost of HBPM per mm Hg lowering of systolic BP per patient, per additional BP controlled, and per life-year gained"*(p e380) ICER Extra cost to gain one life-year
Fishman,[20] 2013, US	*"Analyze the cost-effectiveness of the Electronic Communications and Home Blood Pressure Monitoring to Improve Blood Pressure Control (e-BP) study, a randomized controlled trial that used a patient-shared electronic medical record, home blood pressure (BP)"*	*"Cost-effectiveness of home BP monitoring and web-based pharmacist care estimated for percent change in patients with controlled BP and cost per mm Hg in diastolic and systolic BP relative to usual care and home BP monitoring alone"*(p 709)	*"778 patients aged 25 to 75 years diagnosed with hypertension…with diastolic blood pressure between 90 and 109 mmHg or mean systolic blood pressure between 140 and 199 mmHg"*(p 710)	*"We calculate incremental cost-effectiveness ratios (ICERs) for the e-BP program for 4 specific outcomes: improved BP control, reduced mm HG systolic and diastolic BP, and change in life expectancy achieved through greater control of hypertension"*(p 712)

Table A2: Characteristics of included cost studies				
First Author, Year, Country,	**Study Objectives**	**Interventions/Comparators**	**Patients**	**Main outcomes**
	monitoring, and web-based pharmacist care to improve BP control (<140/90 mm Hg). (p 709)			ICER Extra cost to gain one life-year
Implantable cardiac devices				
Costa,[21] 2013, Portugal	*"Our aim was to evaluate the applicability of the CareLink_ (Medtronic, Minneapolis, MN) remote monitoring system as a complementary option to the follow-up of patients with implanted devices, between in-office visits"* (p 71)	2 remote appointment + 2 in-office appointment (scenario 1) 4 in-office appointment (scenario 2)	15 patients (63.4 ± 10.8 years old) *"The target population was composed of all patients with an implanted cardioversion-defibrillation and/or resynchronization device for more than 3 months before enrollment"* (p 72)	*"Evaluated outcomes included both clinical (event detection and time to diagnosis) and nonclinical (patient's satisfaction and economic costs) aspects"* (p 71) Total health care sector costs
Burri,[22] 2013, UK, Switzerland, Australia, Germany	*"The objective of this evaluation is to assess the long-term costs and consequences of using remote CIED management in patients implanted with implantable cardioverter defibrillators (ICDs) and cardiac resynchronization therapy defibrillators (CRT-Ds) for either primary or secondary prevention"* (p 1602)	*"A cost–consequence evaluation comparing HM (daily home monitoring) vs. CFU (conventional periodical in-office follow-up) was performed using a Markov cohort model"* (p 1601)	*"The patient population represented in the model consists of patients who have undergone an ICD or CRT-D implantation and are managed in an outpatient setting"* (p 1602)	Costs (total health care sector costs - Markow model) Sample size: 1000 patients Amortization period: 10 years
Calo,[23] 2013, Italy	*"Our study aimed at assessing current direct costs of 1-year ICD follow-up based on RM compared with conventional quarterly in-hospital follow-ups"* (p 69)	*"Patients with indications for ICD were consecutively recruited and randomized at implant to be followed up for 1 year with standard quarterly in hospital visits or by RM with one in-hospital visit at 12 months"* (p 69)	*"233 patients with standard indications for ICD"* (p 70)	Costs (total health care sector costs)

ICER: incremental cost-effectiveness ratio; NHS: national health services

Appendix 4: Summary of Critical Appraisal of Included Studies

Table A3: Summary of Critical Appraisal of Included Study		
First Author, Publication Year	**Strengths**	**Limitations**
Critical appraisal of included systematic reviews (AMSTAR[10])		
Omboni,[13] 2013	• a priori design provided • duplicate study selection and data extraction procedure in place • comprehensive literature search performed • list of included studies, study characteristics provided • quality assessment of included studies provided and used in formulating conclusions • conflict of interest stated	• list of excluded studies not provided, • no assessment of publication bias performed • considerable heterogeneity in the interventions and demographics among the included trials
Kotb,[14] 2014	• a priori design provided • duplicate study selection and data extraction procedure in place • comprehensive literature search performed • list of included studies, study characteristics provided • quality assessment of included studies provided and used in formulating conclusions • conflict of interest stated	• list of excluded studies not provided, • no assessment of publication bias performed • considerable heterogeneity in the interventions and demographics among the included trials
Huang,[15] 2015	• a priori design provided • duplicate study selection and data extraction procedure in place • comprehensive literature search performed • list of included studies, study characteristics provided • quality assessment of included studies provided and used in formulating conclusions • conflict of interest stated	• list of excluded studies not provided, • no assessment of publication bias performed • considerable heterogeneity in the interventions and demographics among the included trials
Lopez-Villegas,[16] 2015	• a priori design provided • duplicate study selection and data extraction procedure in place • comprehensive literature search performed • list of included studies, study characteristics provided • quality assessment of included studies provided and used in formulating conclusions • conflict of interest stated	• list of excluded studies not provided, • no assessment of publication bias performed • considerable heterogeneity in the design, interventions and demographics among the included trials
Parthiban,[17] 2015	• a priori design provided • duplicate study selection and data extraction procedure in place • comprehensive literature search performed • list of included studies, study characteristics provided • quality assessment of included studies provided and used in formulating conclusions	• list of excluded studies not provided, • no assessment of publication bias performed • considerable heterogeneity in the interventions and demographics among the included trials • conflict of interest not stated

Table A3: Summary of Critical Appraisal of Included Study		
First Author, Publication Year	**Strengths**	**Limitations**
Critical appraisal of included cost studies (Drummond[11])		
Stoddart,[18] 2013	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units prior to evaluation; outcomes and costs valued credibly; outcomes and costs adjusted for different times at which they occurred) • an incremental analysis of the outcomes and costs of alternatives performed • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	• relatively short period of follow-up (6 months) limiting the potential of long-term outcomes • generalizability limited to an UK context
Billups,[19] 2014	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units prior to evaluation; outcomes and costs valued credibly; outcomes and costs adjusted for different times at which they occurred) • an incremental analysis of the outcomes and costs of alternatives performed • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	• relatively short period of follow-up (6 months) limiting the potential of long-term outcomes
Fishman,[20] 2013	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units prior to evaluation; outcomes and costs valued credibly; outcomes and costs	• generalizability may be limited due to the majority white population with a college degree

Table A3: Summary of Critical Appraisal of Included Study		
First Author, Publication Year	**Strengths**	**Limitations**
	adjusted for different times at which they occurred) • an incremental analysis of the outcomes and costs of alternatives performed • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	
Costa,[21] 2013	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units prior to evaluation; outcomes and costs valued credibly; outcomes and costs adjusted for different times at which they occurred) • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	• very small sample size (15 patients) • incremental analysis of the outcomes and costs of alternatives not performed • generalizability limited to a Portugal context
Burri,[22] 2013	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units prior to evaluation; outcomes and costs valued credibly; outcomes and costs adjusted for different times at which they occurred) • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	• incremental analysis of the outcomes and costs of alternatives not performed • generalizability limited to an European context
Calo,[23] 2013, Italy	• the economic evaluation is likely to be usable (a well-defined question posed in an answerable form; a comprehensive description of the competing alternatives given; evidence for the programme's effectiveness established) • outcomes and costs assessed and compared appropriately (all the important and relevant outcomes and costs for each alternative identified; outcomes and costs measured accurately in appropriate units	• incremental analysis of the outcomes and costs of alternatives not performed • generalizability limited to an Italian context

Table A3: Summary of Critical Appraisal of Included Study		
First Author, Publication Year	**Strengths**	**Limitations**
	prior to evaluation; outcomes and costs valued credibly; outcomes and costs adjusted for different times at which they occurred) • a sensitivity analysis performed • the presentation and discussion of study results include all issues of concern to users	
Critical appraisal of included guidelines (AGREE[12])		
Yee,[24] 2013	• scope and purpose of the guidelines are clear • the recommendations are specific and unambiguous • the method for searching for and selecting the evidence are clear • methods used for formulating the recommendations are clearly described • health benefits, side effects and risks were stated in the recommendations • target users of the guideline are clearly defined	• unclear whether the guideline was piloted among target users • unclear whether patients' views and preferences were sought • potential cost implications of applying the recommendation not included • procedure for updating the guidelines not provided

Appendix 5: Main Study Findings and Authors' Conclusions

Table A4: Main Study Findings and Authors' Conclusions

First Author, Publication Year	Main Study Findings	Authors' Conclusions
Research question 1 (clinical evidence regarding telehealth interventions for patients with hypertension, coronary artery diseases and implantable cardiac devices requiring cardiac care)		
Hypertension		
Omboni,[13] 2013	**BP change compared to usual care** SBP: HBPT improved office SBP [WMD4.71mmHg [95% confidence interval (CI): 6.18, 3.24; P<0.001] DBP: HBPT improved office DBP (WMD 2.45mmHg; 95% CI 3.33, 1.57; P<0.001) **Proportion of patients achieved office BP normalization (<140/90mmHg nondiabetic patients and <130/80mmHg diabetic patients)** HBPT led to a significantly larger proportion (RR: 1.16; 95% CI 1.04, 1.29; P<0.001) **Prescription of antihypertensive medications** HBPT led to a significantly larger prescription of antihypertensive medications (WMD+0.40 (95% CI +0.17; +0.62, P<0.001) **Quality of life** HBPT helped improving the physical component of quality of life (SF-12 or SF-36 questionnaire: WMD +2.78; 95% CI +1.15, +4.41; P<0.001) **Therapeutic adherence, rate of office consultations, risk of adverse events** No statistically significant difference in both intervention and usual care groups	*"HBPT may represent a useful tool to improve hypertension control and associated healthcare outcomes although it is still more costly compared with usual care"* (p 455)
Coronary Artery Diseases		
Kotb,[14] 2014	**All-cause mortality** No difference between the telephone group and the group receiving standard care (OR 1.12; 95% CI 0.71, 1.77) **Hospitalizations** The intervention was significantly associated with fewer hospitalizations than the comparison group (OR 0.62; 95% CI 0.40, 0.97). **Low density lipoprotein** No statistically significant difference between the 2 groups (WMD -0.10; 95% CI -0.23, 0.03) **Smoking** Significantly more participants in the telephone group stopped smoking (OR 1.32; 95% CI 1.07, 1.62) **Patient-reported outcomes** **Depression** Significantly more participants in the telephone group had lower depression scores (SMD -0.10; 95% CI-0.21,0.00); and lower anxiety scores (SMD -0.14; 95% CI -0.24, -0.04).	*"Compared to standard post-discharge care, regular telephone support interventions may help reduce feelings of anxiety and depression as well as, improve systolic blood pressure control and the likelihood of smoking cessation"* (p 1)

Table A4: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
Huang,[15] 2015	No statistically significant difference was found between telehealth interventions delivered and center-based supervised CR in **All-cause mortality** (RR 1.15; 95% CI 0.61, 2.19) **Exercise capacity** (SMD -0.01; 95% CI -0.12, 0.10) **Weight** (SMD -0.13; 95% CI -0.30, 0.05) **Systolic and diastolic blood pressure** (mean difference (MD -1.27; 95% CI -3.67, 1.13 and MD 1.00; 95% CI -0.42, 2.43, respectively) **Total cholesterol** (MD 0.19; 95% CI -0.02; 0.39) **Smoking** (RR 1.03; 95% CI 0.78, -1.38) **Quality of life** (SMD 0.13; 95% CI 0.00, 0.27) **Psychosocial state** Anxiety(SMD 0.11; 95% CI -0.04, 0.27) Depression (SMD 0.03; 95% CI -0.12, 0.18)	*"Telehealth intervention delivered cardiac rehabilitation does not have significantly inferior outcomes compared to center-based supervised program in low to moderate risk CAD patients. Telehealth intervention offers an alternative deliver model of CR for individuals less able to access center-based cardiac rehabilitation. Choices should reflect preferences, anticipation, risk profile, funding, and accessibility to health service"* (p 959)
Implantable Cardiac Devices		
Lopez-Villegas,[16] 2015	**Cardiovascular events** Detected and treated 2 months earlier with telemonitoring than with conventional monitoring (no quantitative data; data from 1 study) **Length of hospital stay, hospital visits** Length of stay: reduced by 34% by telemonitoring (no quantitative data; data from 1 study) Hospital visits: data not reported **Quality of life or number of adverse events** There were no significant differences between groups(no quantitative data; data from 1 study)	*"Compared with conventional monitoring, cardiovascular events were detected earlier and the number or hospitalizations and hospital visits was reduced with pacemaker telemonitoring"* (p 1)
Parthiban,[17] 2015	**All-cause mortality** There were no significant differences between groups (OR 0.83; p =0.285) A reduction in all-cause mortality was noted in the 3 trials using home monitoring (OR 0.65; p = 0.021) with daily verification of transmission **Cardiovascular mortality** There were no significant differences between groups OR 0.66; p = 0.103 **Hospitalization** There were no significant differences between groups(OR 0.83; p =0.196) **Odds of receiving any ICD shock** were similar in RM and IO patients (OR 1.05; p = 0.86), **Odds of inappropriate shock** were reduced in RM patients (OR 0.55; p = 0.002).	*"Meta-analysis of RCTs demonstrates that RM and IO follow-up showed comparable overall outcomes related to patient safety and survival, with a potential survival benefit in RCTs using daily transmission verification. RM benefits include more rapid clinical event detection and a reduction in inappropriate shocks"* (p 2591)

Table A4: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
Research question 2 (cost-effectiveness of telehealth interventions for patients with hypertension, coronary artery diseases and implantable cardiac devices requiring cardiac care?)		
Hypertension		
Omboni,[15] 2013	**Healthcare costs (total costs: intervention operating costs plus medical costs)** Significantly larger in the HBPT group: weighted mean difference 662.92 [95% confidence interval (CI) 540.81 to 785.04] euros per patient(P<0.001) **Costs when only medical costs were considered** No statistically significant difference between HBPT and usual care group but were similar to those of the usual care	*"HBPT may represent a useful tool to improve hypertension control and associated healthcare outcomes, although it is still more costly compared with usual care"* (p 455)
Stoddart,[18] 2013	**Healthcare costs (total costs)** Monitored group: £290.13 Usual care: £174.81 Mean difference: £115.32 (95% CI 83.49 to 146.63) P < 0.001 ICER per 1 mm Hg lowering of SBP £25.56/mm Hg (95% CI 16.06 to 46.89) P < 0.001	*"Over the 6-month trial period, supported telemonitoring was more effective at reducing BP than usual care but also more expensive. If clinical gains are maintained, these additional costs would be very likely to be compensated for by reductions in the cost of future cardiovascular events"* (p 1)
Billups,[19] 2014	Total healthcare costs HBPM: US$1590 (95% CI 934, 2841) Usual care: US$1283 (95% CI 681, 2383) P = 0.008 ICER per life-years gained HBPM: US$3330 per additional life year gained (P value not reported) ICER per additional 1 mm Hg lowering of SBP HBPM: US$20.50 (P value not reported) ICER per additional controlled BP achieved HBPM: US$1331 (P value not reported)	*"The HBPM program requires investment in outpatient encounters, medications, and laboratory monitoring, but produces significantly improved BP control"* (p e380)
Fishman,[20]	ICER per life-years gained HBPM plus pharmacist care (e-BP): US$1850 (95% CI 1635.76, 2064.24) for men. P < 0.05 US$2220 (95% CI 1745.09, 2694.91) for women. P value not reported ICER per additional 1 mm Hg lowering of SBP HBPM plus pharmacist care (e-BP): US$65.29 (95% CI 59.91, 70.67) P < 0.05 ICER per additional 1 mm Hg lowering of DBP HBPM plus pharmacist care (e-BP): US$114.82 (95% CI 111.90, 117.74) P< 0.05 ICER per 1% improvement in number of patients with controlled BP using HBPM plus pharmacist care: US$16.95 (95% CI 15.37, 17.94) P<0.05	*"Web-based collaborative care can be used to achieve BP control at a relatively low cost. Future research should examine the cost impact of potential long-term clinical improvements"* (p 709)

Table A4: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
Implantable Cardiac Devices		
Lopez-Villegas,[16] 2015	**Staffing costs** *Significantly lower in the TM group (18.0 ± 41.3 euros vs 22.4 ± 26.9 euros; P < .003).*(p 9) (data from 1 study; costs included: staffing costs; 27 months follow-up) **Transport cost** *The potential savings for the National Health Service associated with ambulance transport were estimated to be 13 594 euros annually, by replacing one follow-up system with the other. This estimation was for 637 patients pertaining to 3 hospitals in Ayrshire, from a total of 783 patients included*(p 4) (data from 1 study; costs included: staff, telephone, transport; 12 months follow-up) *The absolute costs of the TM group were lower than those of the standard outpatient group by almost 60% (872.14 euros vs 2162.78 euros)*(p 4) (data from 1 study; costs included: staffing costs, transport costs; 27 months follow-up) **Diverse costs** *A saving of 17247 euros over the 3 years that the research lasted, if the 96 patients included in the study had had the data transmission system instead of emergency department visits*. (p 4) (data from 1 study; costs included monthly costs of routine and emergency visits; emergency department costs; 36 months follow-up) *The differences in economic impact are evident in a number of studies that found TM to be up to 4 to 8 times cheaper than the conventional option. Patients in the TM group had a mean of 2 visits less (TM vs HM, 5.92 vs 7.1).* (p 4) (data from 2 studies, costs included: staff, laboratory, indirect costs such as physicians and paramedics, transport; 10 and 20 months follow-up each) *A mean difference of 20.5% in costs between the 2 groups. If patients had to travel to hospital by ambulance, the difference rose to 66.5%*. (p 4) (data from 1 study; costs included: health care costs such as physicians, nurses, transport; informal costs such as transport and productivity, NHS costs such pacemaker check costs; 80 months follow-up)	*"The cost of telemonitoring was 60% lower than that of conventional hospital monitoring"* (p 1)
Costa,[21] 2013	Scenario 1 (2 remote appointments and 2 in-office appointments) Cost per patients (median): €118.00 Total follow-up cost: €2,276.40 Scenario 2 (4 in-office appointments) Cost per patients (median): €136.00 Total follow-up cost: 3,052.80€ (difference €776.40)	*"The introduction of remote monitoring technology has the ability to reduce total follow-up costs for patients by 25%"* (p 71)
Burri,[22] 2013	Total costs per patient over 10 years Home monitoring: £11,452 Conventional in-office visits: £11,486 (difference -34; -0.3%)	*"From a UK National Health Service perspective, HM is cost neutral over 10 years. This is mainly accomplished by reducing the*

Table A4: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
		number of battery charges and inappropriate shocks, resulting in fewer device replacements, and by reducing the number of in-clinic FU visits" (p 1601)
Calo,[23] 2013	Total hospital costs/patient/year (staff costs, equipment, technology purchase) Remote monitoring: US$ 103±27 Conventional in-hospital visits: US$ 154±21 (p=0.01). Total social costs/patient/year (visit costs, transportation, lost income) Remote monitoring: US$ 97±121 Conventional in-hospital visits US$ 287±160 (p=0.0001).	*"The time spent by the hospital staff was significantly reduced in the RM group. If the costs for the device and service are not charged to patients or the provider, patients could save about USD 190 per patient/year while the hospital could save USD 51 per patient/year"* (p 69)
Research question 3(evidence-based guidelines regarding telehealth interventions for patients with hypertension, coronary artery diseases and implantable cardiac devices requiring cardiac care)		
Implantable Cardiac Devices		
Yee,[24] 2013	1.*"We recommend that DFCs integrate RM capability into their routine functions and include this service as part of the standard of care for CIED patients (Strong Recommendation, Moderate-Quality Evidence)"* (p 646) 2.*"We recommend that RM should only be implemented in CIED patients who provide explicit consent after proper education about the nature of RM, its potential benefits and limitations, and how RM-transmitted information will be managed and used. The medicolegal implications of RM and the effect on patient privacy and confidentiality of personal health information should be included in such discussions (Strong Recommendation, Very Low-Quality Evidence)"* (p 646) 3. *"We suggest that, in CIED patients in whom no device issues are identified, routine follow-up assessment during the maintenance phase should blend RM with in-clinic assessments beginning after the 3-month postimplant assessment, alternating assessments between in-clinic and RM transmissions in a 1:1 ratio (Conditional Recommendation, Low-Quality Evidence)"* (p 647) 4. *"We recommend that RM be used to supplement in-person monitoring of the patient and device in clinical circumstances that warrant more intensive surveillance of the CIED, and the evidence suggests that RM might be efficacious (Strong Recommendation, Low-Quality Evidence)"* (p 647) 5. *"We recommend that DFCs develop the infrastructure, resources, policies, and procedures to optimally support the RM program in a manner analogous to in-clinic assessment (Strong Recommendation, Very Low-Quality Evidence)"* (p 647) 6. *We recommend that health professionals responsible for interpretation of RM transmissions and subsequent patient management decisions have the same*	*"…This position statement recommends that remote monitoring be available at all device follow-up clinics as an integral part of the standard of care of device patients…"* (p 645)

Table A4: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
	qualifications, training, and experience as those performing in-clinic assessments (Strong Recommendation, Low-Quality Evidence) (p 647) 7. *We suggest that representatives of private industry involved in RM systems should provide support but should not have any direct involvement in RM-related patient care (Strong Recommendation, Very Low-Quality Evidence)* (p 647)	

CIED: cardiovascular implantable electronic devices; CR: cardiac rehabilitation; DBP: diastolic blood pressure; DFC: device follow-up clinic; FU: conventional periodic in-office visit; HBPT: home blood pressure telemonitoring; HM: daily home monitoring; ICD: implantable cardioverter-defibrillators; ICER: incremental cost-effectiveness ratio; IO: conventional in-office follow-up; OR: odds ratio; RM: remote monitoring; RR: relative risk; SBP: systolic blood pressure; SDM: standardized mean difference; WMD: weighted mean difference