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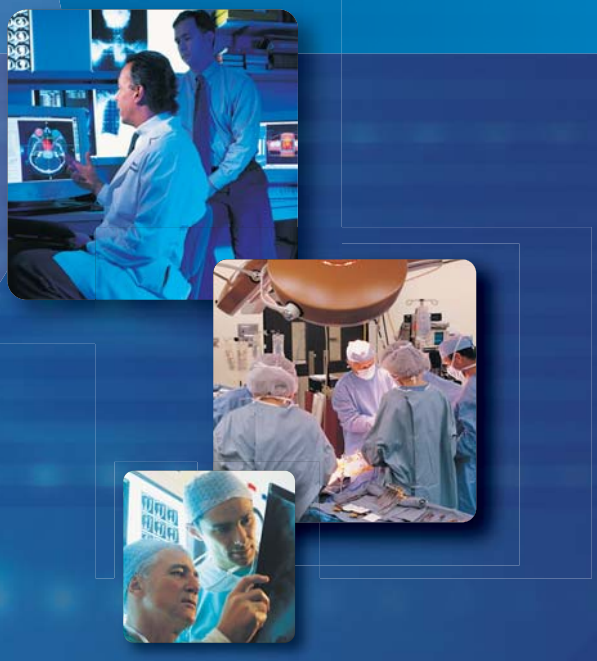

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CADTH
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Canadian Agency for Drugs and Technologies in Health

Home Telehealth for Chronic Disease Management

Khai Tran, MSc PhD[1]
Julie Polisena, MSc[1]
Doug Coyle, MA MSc PhD[2]
Kathryn Coyle, BScPhm MSc[3]
Eike-Henner W. Kluge, PhD[4]
Karen Cimon, MLT[1]
Sarah McGill, BSc MLIS[1]
Hussein Noorani, MSc[1]
Krisan Palmer, RN[5]
Richard Scott, PhD[6]

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[1] Canadian Agency for Drugs and Technologies in Health (CADTH), Ottawa, ON
[2] Department of Epidemiology and Community Medicine, University of Ottawa, Ottawa, ON
[3] Coyle Consultancy, Ottawa, ON
[4] Department of Philosophy, University of Victoria, Victoria, BC
[5] Atlantic Health Sciences Corporation, Saint John, NB
[6] Global eHealth Research and Training Program, University of Calgary, Calgary, AB

Reviewers

These individuals kindly provided comments on this report:

External Reviewers

Silvana Bosca, BSc.P.T
Director, Research and Development
Telehealth Coordinator
Health Region A
Bathurst, NB

Edward M. Brown, MD BM CCFP(EM)
CEO
The Ontario Telemedicine Network
Toronto, ON

Marion E. Jones, PhD Economics
Associate Professor
University of Regina
Regina, SK

Rick Audas, BBA MBA MA (Econ) PhD
Assistant Professor, Faculty of Medicine
Memorial University of Newfoundland
St. John's, NL

Brian Hutton, MSc
Methodologist
OHRI
Ottawa, ON

Natasha Wiebe, MMath PStat
Research Associate
University of Alberta
Edmonton, AB

Nola M. Ries, MPA LLM
Research Associate, Health Law Institute
University of Alberta
Adjunct Assistant Professor, Faculty of Human & Social Development
University of Victoria
Victoria, BC

Tanya Horsley, PhD
Research Associate, RCPSC
Department of Epidemiology and Community Medicine
University of Ottawa
Ottawa, ON

CADTH Peer Review Group Reviewers

Penny Jennett, BA MA PhD CCHRA(C)
Professor Emeritus, Faculty of Medicine
University of Calgary
Calgary, AB

Michelle L. McIsaac, MA
Health Economist
University of Sydney
Sydney, AU

Industry: The following manufacturers were provided with an opportunity to comment on an earlier version of this report: McKesson Canada, New IT Healthcare, Philips Medical Systems Canada, Honeywell HomMed. All comments that were received were considered when preparing the final report.

This report is a review of existing public literature, studies, materials, and other information and documentation (collectively the "source documentation") that are available to CADTH. The accuracy of the contents of the source documentation on which this report is based is not warranted, assured, or represented in any way by CADTH, and CADTH does not assume responsibility for the quality, propriety, inaccuracies, or reasonableness of any statements, information, or conclusions contained in the source documentation.

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Authorship

Khai Tran, the research lead, coordinated the research project and wrote the clinical sections of the report. Khai Tran and Julie Polisena selected studies and extracted, tabulated, and analyzed data.

Julie Polisena participated in the clinical review and the writing of the clinical sections, performed the primary economic analysis (cost analysis), and wrote the section on home telehealth programs in Canada.

Karen Cimon contributed to article selection, study quality assessment, data extraction, tabulation of data including the table of technologies available in Canada, and preparation of the report.

Sarah McGill was responsible for the design and execution of the literature search strategies, for the associated appendix, and for the bibliographies.

Doug Coyle and Kathryn Coyle were responsible for the economics sections. They selected studies; extracted, tabulated, and analyzed data; and wrote the economic sections of the report.

Eike-Henner W. Kluge contributed to research and acquisition of data on the ethical and legal issues, analysis and interpretation of data, and writing of the ethics and legal section.

Hussein Noorani assisted in the conception and design of the project and reviewed the health services impact section.

Krisan Palmer contributed to the conception and definition of the research questions, provided consultations during development and execution of the study, and approved the document.

Richard Scott contributed to conceptual development of the study, provided consultations during development and execution of the study, and approved the document.

All authors critically reviewed and commented on the draft report.

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Conflicts of Interest

No conflicts of interest were declared by the authors.

Dr. Edward Brown is the CEO of The Ontario Telemedicine Network, which manages one of the telehomecare programs that are listed in the study.

EXECUTIVE SUMMARY

Issue

The in-home management of chronic diseases that occur in an aging population presents a challenge to the Canadian health care system. The issues include the improvement and maintenance of patients' quality of life (QoL) and health status, the avoidance of unnecessary trips to emergency departments, a reduction in hospital readmissions, and a reduction of costs.

Objective

The aim of this review was to systematically evaluate the clinical benefit and to review the cost-effectiveness of home telehealth versus usual care or no care for the management of diabetes, heart failure, and chronic obstructive pulmonary disease (COPD). Other chronic diseases that could be managed by using home telehealth; the criteria and tools that are used to identify eligible patients; the strategies for the integration of home telehealth into the Canadian health care system; the technologies that are available in Canada; the health care resource implications; the risk management frameworks; and the ethical, legal, and psychosocial issues were also presented.

Questions and Findings

1. ***What chronic diseases have been managed through real-time and asynchronous home telehealth approaches in Canada and internationally?***
   This review covers diabetes, heart failure, and COPD. In addition, home telehealth has been used in Canada and elsewhere to manage other chronic diseases, including cardiovascular diseases, hypertension, asthma, renal failure (hemodialysis, peritoneal dialysis), chronic wound care, HIV/AIDS, mental health (bulimia nervosa, dementia, Alzheimer disease, depression, schizophrenia), inflammatory bowel disease, pediatric oncology, sleep disorders, cancer, cystic fibrosis, chronic brain injury, chronic migraine, chronic pain, arthritis, and obesity.

2. ***What criteria and tools have been developed to identify patients for whom the provision of home telehealth services would be suitable?***
   Criteria and tools that could be used to identify patients for whom the provision of home telehealth would be suitable were not found. This remains an essential area for future research if home telehealth is to become an integral part of health care services delivery.

3. ***What strategies could be, or are being, used for the integration of home telehealth into existing delivery models in Canada?***
   Six of 10 Canadian provinces have established home telehealth programs. Other jurisdictions and health authorities have pilot or planned projects.

4. ***What have been the clinical outcomes when chronic medical conditions are managed through real-time and asynchronous home telehealth in comparison with regular home care?***
   A systematic review was performed to examine the clinical outcomes of home telehealth compared with those of usual care. In this report, home telehealth was classified as home telemonitoring, which involves data transmission and audio or video monitoring, and

telephone support, where patients are followed up using telephone calls. Usual care was the only comparator that was identified.

Seventy-nine reports describing 78 unique studies were selected for inclusion. Of these, 26 studies examined type 1 and type 2 diabetes, 35 examined heart failure, nine examined COPD, and eight examined mixed chronic diseases. The study quality varied from very high (18 RCTs) to very low (three observational studies).

Among patients with diabetes or heart failure, home telehealth interventions were generally found to be clinically effective (better glycemic control and lower mortality). Studies on COPD reported a higher mortality among patients using home telehealth. The number of studies, however, is small (n=1 for home telemonitoring and n=3 for telephone support), so the outcomes should be interpreted with caution.

In terms of health services utilization, the study results were more varied. The overall trend suggests that patients using home telehealth interventions use fewer health services, such as hospitalizations, emergency department visits, and bed days of care. In contrast, patients in the home telehealth group had a greater number of primary care, specialist, office (visit to family physician, specialist, nurse), and home care visits. The number of studies on these outcomes was limited (n<5), so the findings must be interpreted with caution. No patient adverse events were reported in any of the studies.

QoL and patient satisfaction outcomes were qualitatively reviewed for diabetes, heart failure, COPD, and mixed chronic diseases. QoL and patient satisfaction were measured using various instruments. The study results indicate that home telehealth interventions were similar or favourable to usual care in terms of QoL, patient satisfaction, adherence to treatment, or compliance.

5. ***What technologies have been available in Canada to provide home telehealth for chronic medical conditions?***
   Equipment and the accompanying software are available in or to Canada and offer an array of complexity, modalities, and approaches (patient monitoring, prompts, reminders). Peripheral devices are used to measure blood pressure, pulse, respiration, glucose, and body temperature.

6. ***What have been the economic impacts of using real-time and asynchronous home telehealth for chronic medical conditions?***
   The review adopted a strategy in which full economic evaluations (considering incremental costs and outcomes) and cost analyses (considering only costs) were included. No attempt was made to quantitatively synthesize the studies that were identified. Instead, data from all included studies were summarized and appraised to identify common results and the related strengths and weaknesses.

   Twenty-two studies were found to be relevant for inclusion in the literature review. One study was a formal full economic evaluation (cost-utility study). The others were cost-

analyses or cost-minimization analyses. No published study of home telehealth involved a formal assessment of utilities or the impact of the program on long-term outcomes.

Most of the studies (12) focused on home telehealth for patients with heart failure. Five studies focused on patients with diabetes, and three focused on patients with COPD. The two remaining studies included patients with different diseases (both studies included patients with diabetes, heart failure, and COPD).

Most of the studies found that home telehealth was cost-saving from the health care system perspective. This was consistent by disease area and by the mode of home telehealth. The quality of these studies in terms of economic evaluations, however, was very poor, so the validity of the study results was questionable. Most of the studies included only comparisons of costs and can not be considered full economic evaluations. Thus, their relevance to decision makers is limited.

7. What are the foreseeable health human resource implications of implementing real-time and asynchronous home telehealth programs?

The health care professional-patient relationship is based on good faith, loyalty, and trust. Because home telehealth is not yet an established part of the education and training of health care professionals, targeted professional education and training should precede the application of home telehealth. The success of home telehealth depends on the skills and knowledge of the home telehealth provider. For instance, the qualifications of response personnel in call-in centres or who monitor patient data must be assessed and comparable with those from whom the patients would otherwise receive care (for example, physicians).

8. and 9. What are the foreseeable privacy and ethical concerns associated with the use of real-time and asynchronous home telehealth from a risk-management perspective?

The ethical, legal, and psychosocial issues in home telehealth fall into four categories: patient-centred issues, professional issues, technology issues, and issues that derive from the social expectations in the *Canada Health Act.*

Patient-centred issues include privacy and confidentiality, informed consent, patient selection, and the psychosocial implications resulting from the medicalization of the home environment. Professional issues centre on liability and malpractice, because home telehealth involves increased patient participation in their own care, and on training, because home telehealth is an uncommon mode of health care delivery. Technology issues centre on reliability, privacy, and safety. The evidence suggests that these issues present no insurmountable ethical or legal problems and that, in many aspects, home telehealth is more advantageous than current models of health care delivery for the conditions that are being studied. There are ethical and legal concerns about the unique patient identifiers that are necessary for home telehealth to function properly. Current evidence suggests that home telehealth, when appropriately implemented, follows the five principles of the *Canada Health Act*.

Conclusion

Despite the limited evidence, this assessment indicates that, overall, home telehealth is effective and that it can reduce health resource use.

The economic studies were highly heterogeneous. More studies of a higher methodological quality are needed to give greater insights into the potential cost-effectiveness of home telehealth interventions. A framework for such studies is suggested.

Home telehealth is a useful addition to Canadian health care delivery. It has been applied in the management of several chronic diseases. Many ethical, legal, and psychosocial issues that may arise can be solved using existing models. Some issues regarding the criteria for identifying suitable patients, liability, reimbursement, and unique patient identifiers, which are crucial to home telehealth implementation, require further discussion.

ABBREVIATIONS

AIDS	acquired immunodeficiency syndrome
BDOC	bed days of care
CI	confidence interval
COPD	chronic obstructive pulmonary disease
CHA	*Canada Health Act*
CHF	congestive heart failure
DALY	disability adjusted life years
FEV_1	forced expiratory volume in 1 second
HbA1c	glycosylated hemoglobin
HIV	human immunodeficiency virus
LOS	length of stay
NYHA	*New York Heart Association*
QALY	quality adjusted life years
QoL	quality of life
RCT	randomized controlled trial
RR	relative risk
SE	standard error

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1 INTRODUCTION

1.1 Background

Chronic diseases are prolonged conditions that usually do not improve with time and that are rarely cured.[1] Diabetes mellitus (all types), heart failure, and chronic obstructive pulmonary disease (COPD) are examples of chronic diseases. Chronic diseases may cause premature deaths, decrease the quality of life (QoL) of individuals, and have a negative economic impact on the individuals' families and on society.[2] In Canada, the total cost of illness, disability, and death due to chronic diseases exceeds C$80 billion annually.[3] Cardiovascular diseases account for C$28 billion per year, diabetes C$14 billion per year, and respiratory illnesses C$8 billion per year.[4] Chronic illnesses are associated with approximately 48,023 deaths annually (21,946 from cardiovascular diseases, 3,617 from chronic respiratory diseases, and 1,927 from diabetes).[5] It has been estimated that there were 350,000 Canadians (1% of the population) with heart failure in 2002.[3] In 2005, COPD was diagnosed in approximately 754,700 Canadian adults older than 34 years of age (4.4% of that age group).[6] The numbers may be larger than those that were reported, because more than half of patients with COPD are undiagnosed.[3]

Chronic disease management is a systematic approach to improving and maintaining the health of patients with chronic diseases and long-term conditions. Patients can play a more active role in their own care, and health care providers may receive the necessary resources and expertise to better assist patients in managing their disease.[1] Home care is an integral part of a chronic disease management model. Advances in treatment have resulted in reduced lengths of hospital stays, and in some cases, the avoidance of hospital visits. As a result, the demand for home care services has increased.[7] Health care providers can deliver home care services by visiting a patient's home or by using information and communication technology (known as "home telehealth").

The evidence suggests that home telehealth generally provides improved access to care, improves the patient's medical condition and QoL, and reduces costs compared with conventional home care or usual care.[8-10] Home telehealth is telehealth that brings health care delivery to the home by connecting the patient and the professional. It is not intended to replace health professional care or visits, but to enhance current care.[3] It encompasses telehomecare and includes the delivery of health services to patients at home to maintain or restore health and to maximize independence while minimizing the effects of disability or illness.[11] Telehomecare, which has been equated with "telemonitoring," refers to programs where patients are monitored in the home, and the data are transmitted to a health care provider at a distant location.[3]

1.2 Overview of Technology

In this review, home telehealth includes home telemonitoring and telephone support.

Home telemonitoring, as defined by the American Telemedicine Association, is remote care delivery or monitoring that occurs between the health care provider and patients in their place of residence. Patient outcome data are transmitted to a health care provider from a remote location. Home telemonitoring services can be classified as synchronous (real-time interaction) or

asynchronous (not real-time). Synchronous technologies refer to information and communication technologies that enable individuals to communicate live over long and short distances.[12] Such technologies include audio and video conferencing. Asynchronous telemonitoring, which is also called "store-and-forward telemedicine," involves the storage of clinical digital samples and relevant data, which are forwarded to a health care professional at a distant site, by email or through the Internet, as video clips or other forms of data transmission, for assessment at a convenient time.[13]

The home telemonitoring infrastructure consists of four components:[3]

- **Client devices**: Software, hardware, and services that are used to assist in managing and monitoring the client's condition.
- **Central systems**: Applications that are used to assist clinicians in managing multiple clients through the central monitoring service and mobile clinical staff providing local support to these clients. The central client management system collects and displays the client's condition-specific vital signs and stores clinical and assessment documentation.
- **Communication network**: Hardware, software, network, and communication infrastructure required for service delivery and operational support to maintain the integrity of the home telehealth system.
- **Provider devices and care team activities**: Software and hardware used for health service delivery to clients using home telehealth and for client-to-provider and provider-to-provider information sharing. It includes clinical staffing and the professional services that are necessary for consultative support to users and clients using home telehealth.

Telephone support is patient or caregiver support (for example, advice, education, follow-up) by a health care provider, usually through telephone contact. It does not involve electronic transmission of patient outcome data to a health care provider.

2 THE ISSUE

Because multiple chronic diseases often occur in the aging Canadian population, there are challenges to the health care system in providing care and services at the patient's residence in urban or rural areas. The issues involve the maintenance and improvement of patient QoL and health status, the avoidance of unnecessary trips to emergency departments, a reduction in hospital readmissions, and a reduction of costs. As a result, there is a need to systematically evaluate the clinical benefit and cost-effectiveness of home telehealth versus conventional homecare for chronic disease management.

3 OBJECTIVES

The research objective was to systematically review the literature and to perform meta-analyses of the use of health care services and the outcomes of home telehealth compared with those of usual care or no care for the management of patients with diabetes, heart failure, and COPD. Usual care involves follow-up by a primary care physician or specialist after patient discharge from hospital. Another objective was to review the literature on cost-effectiveness and to provide

a framework for economic evaluations of home telehealth. In addition, the ethical, legal, and psychosocial issues that are associated with home telehealth are presented.
The objectives were accomplished by addressing nine questions.

1. What chronic diseases have been managed through real-time and asynchronous home telehealth approaches in Canada and internationally?
2. What criteria and tools have been developed to identify suitable patients for whom home telehealth would be provided?
3. What strategies could be, or are being, used for the integration of home telehealth into delivery models in Canada?
4. What have been the clinical outcomes for chronic medical conditions managed through real-time and asynchronous home telehealth in comparison with regular home care?
5. What technologies have been available in Canada for the provision of home telehealth in the management of chronic medical conditions?
6. What have been the economic impacts of using real-time and asynchronous home telehealth approaches for chronic medical conditions?
    a. For which disease conditions are real-time and asynchronous home telehealth most advantageous?
    b. What other factors (clinical and economic) have been shown to influence the efficiency of these approaches?
7. What are the foreseeable health human resource implications of implementing real-time and asynchronous home telehealth programs?
8. What are the foreseeable privacy and ethical concerns associated with the use of real-time and asynchronous home telehealth?
9. What are the known risk management frameworks for operating real-time and asynchronous home telehealth programs?

4 CLINICAL REVIEW

4.1 Methods

A protocol for the systematic review was written a priori.

4.1.1 Literature search strategy

Literature searches were conducted for the clinical and health services impact section (Appendix 1). All search strategies were developed by an information specialist with input from the project team and were peer-reviewed by an internal information specialist who was uninvolved in the project. The results were limited to articles that were published from 1998 to 2008, with no language restrictions. For questions 8 and 9, the search was limited to the years

1993 to 2008 so that the work based on formative international conferences on informatics and medicine in the early 1990s could be captured.

The following bibliographic databases were searched through the Ovid interface: MEDLINE, MEDLINE Daily Update, MEDLINE In-Process & Other Non-Indexed Citations, BIOSIS Previews, and EMBASE. For the clinical component, CINAHL and PsycINFO were also searched. Parallel searches were run in PubMed, The Cochrane Library, CRD Health Technology Assessment (HTA), plus the Health Economic Evaluations Database (HEED) and the CRD NHS Economic Evaluation Database (NHS EED) for the economic component. The search strategy included the standard controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings) and keywords. The main search concept was home telehealth. The results on chronic diseases [including diabetes, COPD, and congestive heart failure (CHF)] were flagged by a focused search. For the economic component, methodological filters were applied to limit retrieval to cost analyses and other economic studies. These searches were supplemented with a focused literature search that was designed to address the health services impact of home telehealth, including research questions 7, 8, and 9. Ovid AutoAlerts and PubMed MyNCBI were set up to send monthly updates for new literature; monthly searches were also performed in The Cochrane Library, HEED, and CRD.

Grey literature (literature that is not commercially published) was identified by searching the websites of health technology assessment and related agencies, professional associations, and other specialized databases. Commercially available search engines were used to search for web-based materials and information. Conference proceedings, hand searches of the bibliographies of key papers, and appropriate expert and agency contacts supplemented the search.

4.1.2 Selection criteria and method

a) Selection criteria

Eligibility criteria for studies involving clinical and health-related QoL outcomes (question 4)

A study was eligible for inclusion only if it satisfied each of the following criteria:

***Study design*:** Any study design.

***Population*:** Patients with any or all of three chronic diseases: diabetes, heart failure, and COPD.

***Intervention*:** Home telehealth (the use of audio, video, or other information and communication technologies to provide care at home and monitor patient status at a distance).

Comparators: Usual care or no care.

***Primary outcomes*:** Health care resource (hospitalizations or readmissions, bed days of care (BDOC), emergency department visits, outpatient visits at primary care clinics or specialist clinics, and home visits by physicians or nurses).

***Secondary* outcomes**: Disease-related health outcomes or death, functional status (anxiety, depression, self-efficacy), compliance, satisfaction, and QoL.

Eligibility criteria for studies involving ethical and legal issues (questions 8 and 9)
Studies were selected on the basis of whether they identified specific ethical or legal issues that were relevant to the project or whether they identified general issues with fundamental implications for e-Health. Priority was given to literature that was published in the last five years. In some instances (particularly for fundamental issues), it was necessary to go beyond that time frame, because contemporary publications assumed familiarity with previous discussions.

b) Selection method
Two reviewers (KT, JP) independently applied the selection criteria and scanned the titles and abstracts that were identified through searching. The full-text articles were obtained for all titles and abstracts that met the selection criteria and for articles that we were unsure whether to include. Articles were subsequently reviewed and included if they met the selection criteria. Any differences were resolved by consensus.

The articles pertaining to ethical, legal, and psychosocial issues were selected by one reviewer (EK).

4.1.3 Data extraction strategy

Data from each included trial were extracted by two reviewers (KT, JP) working independently and using a structured form (Appendix 2). Data were verified for discrepancies and tabulated by KT and KC. Disagreements were resolved by consensus.

One author (EK) extracted data and wrote the sections on ethical, legal, and psychosocial issues.

4.1.4 Strategy for quality assessment

The quality of the included studies was independently evaluated by two reviewers (KT and JP) using a modified version of a tool developed by David Hailey et al.[9] The quality of the studies was rated on a scale of A to E. This is a combination of the Jadad scale and the Hailey et al. scale. The ratings are based on study design and study performance and are applicable to randomized and non-randomized studies (Appendix 2, second table).

Table 1: Quality Ratings

Category	Overall Score	Description
A	11.5 to 15.0	High quality — high degree of confidence in study findings
B	9.5 to 11.0	Good quality — some uncertainty regarding study findings
C	7.5 to 9.0	Fair to good quality — some limitations that should be considered in implementation of study findings
D	5.5 to 7.0	Poor to fair quality — substantial limitations in study; findings should be used cautiously
E	1 to 5.0	Poor quality — unacceptable uncertainty in study findings

No quality assessment was given to articles on ethical, legal, and psychosocial issues.

4.1.5 Data analysis methods

STATA 8.2 was used for all the statistical analyses in the clinical review. Where the quantitative pooling of results was appropriate, the random effects model was used to compute treatment efficacy to measure the average effects of the intervention across all studies. The quality scores, clinical and health services utilization outcomes, and conclusions were presented for each study that was included in the clinical review.

The count data (for example, the number of hospitalizations) were summarized as rate ratios [ratio of the rate in the experimental intervention group (for example, home telemonitoring or telephone support) to the rate in the control group (for example, usual care)] to measure the number of events that occurred per patient and to account for the varying lengths of follow-up. We used the natural logarithm of the rate ratio in our analyses:[14]

Log (rate ratio) = Log $((E_I/T_I)/(E_C/T_C))$ = Log $((E_I T_C)/(E_C T_I))$,
where E_I=number of events that occurred during T_I person-years of follow-up in intervention group, and Ec=number of events that occurred during Tc person-years of follow-up in control group.

Standard error of log rate ratio = $\sqrt{1/E_I + 1/E_C}$

For studies that reported the mean number of events, the mean outcome was multiplied by the number of patients at the end of the follow-up period to obtain the number of events per group.

The relative risk (or risk ratio), which compares the event rate in the intervention group to the event rate in the usual care group, was used to summarize dichotomous data. In our study, the dichotomous outcomes that were measured include the number of patients who were rehospitalized, number of patients who visited the emergency department, and number of deaths.

Continuous data with variances (standard deviation or standard error) were summarized using mean differences. Where no variance was reported, a value was imputed. The coefficient of variation was calculated based on studies with similar population, study design, and intervention and the same outcomes.[15] Missing data were imputed for randomized controlled trials (RCTs) that measured glucose control [glycosylated hemoglobin (HbA1c)] in the population with diabetes. Data imputation was not conducted for observational studies, because of the variation in designs and the inherent risk of bias.[16] All standard error (SE) values were converted to standard deviation values, and all summary estimates were presented with the 95% confidence interval.

The statistical heterogeneity between studies was measured using the I^2 statistic, which quantifies the percentage of variation across studies that is due to heterogeneity rather than chance.[17] For example, an I^2 statistic of 35% indicates that 35% of the observed variance between studies is due to real differences in the effect size, while 65% may be due to random error. Attempts were made to explain substantial statistical heterogeneity ($I^2 \geq 50\%$) by conducting subgroup analyses. Where statistical heterogeneity remained present in the subgroup analyses, clinical outcomes were presented separately for each study and were reviewed

qualitatively. No attempt was made to pool the outcomes of the mixed chronic diseases studies, because the patient populations were diverse.

The I^2 statistic explores variation between studies. The test, however, does not provide evidence about clinical heterogeneity in terms of study design, patient population, treatments, and health care system characteristics. This is paramount in an evaluation of home telehealth, because the intervention, comparator, patient population, and health care system in which the study is conducted may vary across studies. Our report provides descriptions of each study to facilitate the examination of clinical heterogeneity. Given the degree of variability among the study characteristics, the results of our meta-analyses should be interpreted with caution.

Study designs that were eligible to be included in the meta-analysis were RCTs and prospective cohort studies with a quality score of C (fair to good) or higher. While RCTs are the "gold standard" in meta-analyses, well-conducted observational studies may provide complementary information and may be no more biased than a high-quality RCT.[16] Subsequently, summary estimates of meta-analyses with RCTs and observational studies were compared with summary estimates of meta-analyses with RCTs alone to measure the impact of observational studies on the effect size.

4.1.6 Home telehealth in Canada

a) Technologies available in Canada for chronic disease management

The *Canadian Telehealth Industry Report* was retrieved in the grey literature search.[18] The information specialist (SM) used this report to compile a preliminary list of Canadian manufacturers and industry contacts. More information was obtained from the e-Health and Telemedicine section of Industry Canada's website[19] and by searching the Internet for manufacturers' websites.

A representative from the Device Licensing Services Division of the Medical Devices Bureau, Health Canada, performed a search of Health Canada's Medical Devices Active Licence Listing database and provided information for licensed Class II, III, and IV telehealth devices and their manufacturers. Class I devices (for example, software that only transmits data from home to hospital or clinic) are not licensed through Health Canada, and therefore could not be included in the search.

Non-Canadian manufacturers of devices available in Canada were located by hand searching articles that were retrieved in the literature search. More information about these devices was obtained by searching the Internet.

b) Home telehealth programs in Canada

An environmental scan of home telehealth programs available in Canada was conducted through email with the appropriate contact person in a regional health authority or ministry of health for each province and territory and by retrieving information from a provincial report[20] and an article.[21] The questions asked of each jurisdiction were:

- Is there a home telehealth care program currently available in your jurisdiction?
- If yes, what are the target population and comorbidities monitored or treated?
- What home telehealth services (real-time or asynchronous) are delivered to the patients?

- What criteria and tools were developed or applied to identify patients who were suitable for the provision of home telehealth services in your jurisdiction?
- Are there any strategies in place to integrate home telehealth into existing delivery models in your jurisdiction? If yes, please describe the strategies.
- Is there available cost or health services utilization or anonymous patient data (raw or in a report) resulting from your home telehealth program?
- If a regional or provincial home telehealth program does not exist in your jurisdiction, are there plans to establish one in the near future? If yes, please provide a brief description.

4.2 Results

4.2.1 Quantity of research available

The original literature search identified 6,236 citations (Figure 1). From these, 820 potentially relevant reports were retrieved for further scrutiny. A total of 79 reports describing 78 unique studies were selected for inclusion.

For report selection regarding ethical and legal considerations (Figure 2), 891 citations were identified in the original literature search. One hundred and seventeen potentially relevant reports were retrieved for further review, and 81 reports were selected for inclusion. The lists of included studies appear in Appendices 3a and 3b.

4.2.2 Study characteristics

The characteristics of the clinical studies pertaining to diabetes (26 studies), heart failure (35 studies), COPD (nine studies), and mixed chronic diseases (eight studies) appear in Appendices 4a, 4b, 4c, and 4d respectively. The patient baseline characteristics appear in Appendices 5a, 5b, 5c, and 5d for diabetes, heart failure, COPD, and mixed chronic diseases respectively. The comparator "no care" was not identified in any of the included studies, so usual care was used throughout our clinical review.

a) Diabetes

Twenty-one studies[22-42] compared home telemonitoring with usual care, and five studies[43-47] compared telephone support with usual care. Of the 21 studies that examined home telemonitoring versus usual care, 12 were RCTs,[23,25,28,29,31,32,35,36,38-41] and nine were observational studies.[22,24,26,27,30,33,34,37,42] There were five RCTs[43-47] in the telephone support versus usual care comparison. A description of the intervention and comparator in each study appears in Appendix 4a.

Among the studies, the length of follow-up varied from three months to three years. Ten studies were from the US,[25-27,35-39,44,45] one from Canada,[46] two from Germany,[23,34] three from Poland,[24,32,41] two from Finland,[28,42] one from Spain,[29] three from South Korea,[30,31,43] one from Italy,[33] and two from China.[40,47] Four studies received funding from industry alone,[23,24,44,46] 15 studies were funded by the government alone,[22,26,27,29-31,33,35-40,43,45] four studies received funding from industry and government,[25,32,34,41] and three studies did not report the source of funding.[28,42,47]

The number of participants in the studies ranged from 28 to 1,665. The patient population consisted of type 1 and type 2 diabetes. Four studies did not specify the type of diabetes.[26,38,39,45] Most studies selected patients who had a stable general medical condition, were able to perform blood glucose testing, and were willing to use a computer or telephone to transmit data. Patients with impaired cognitive function, a language barrier, and other major chronic diseases were excluded in most studies.

b) Heart failure

Twenty studies[48-67] compared home telemonitoring with usual care, and 18 studies[52,56,57,68-82] compared telephone support with usual care. Three studies[52,56,57] had three comparative arms: home telemonitoring, telephone support, and usual care. Of the 20 studies in the home telemonitoring versus usual care comparison, 11 were RCTs,[48,49,51,52,54-58,64,67] and nine were observational studies.[50,53,59-63,65,66] Thirteen RCTs[52,56,57,69-73,75,76,78,79,81] and five observational studies[68,74,77,80,82] compared telephone support with usual care. Appendix 4b includes a description of the intervention and comparator of each study.

The length of follow-up in the studies varied from two to 16 months. Twenty-seven studies were from the US;[48-50,53,55-57,59-61,63-66,68-72,74-80,82] two studies were from Canada;[67,81] one study was from the UK;[58] two studies were from Italy;[51,54] one study was from the Netherlands, UK, and Germany;[52] one study was from Argentina;[73] and one study was from Israel.[62] Six studies received funding from industry alone,[55,58,67,70,78,81] 14 studies were funded by government alone,[48,49,51,54,56,63-65,69,71,72,79,80,82] four studies received funding from industry and government,[52,73,74,76] and 11 studies did not report the source of funding.[50,53,57,59-62,66,68,75,77]

The number of participants in each study ranged from 22 to 1,518. Participants in all of the studies had a mean age of more than 55 years, and most had a mean New York Heart Association functional classification of 3 to 4. Patients with a history of mental illness, cognitive impairment, life expectancy of less than six months to one year, a language barrier, and other major chronic diseases were excluded in most studies.

c) Chronic obstructive pulmonary disease

Of the nine included studies of COPD, four[83-86] compared home telemonitoring with usual care, and five[87-91] compared telephone support with usual care. All the studies comparing telephone support with usual care were RCTs, and one RCT[84] compared home telemonitoring with usual care. A description of the intervention and comparator in each study appears in Appendix 4c.

The length of follow-up ranged from three months to one year. Two studies were from Canada,[83,87] two from Spain,[84,90] one from Spain and Belgium,[88] one from Australia,[89] one from the Netherlands,[85] one from Greece,[86] and one from China.[91] One study was funded by industry,[87] five received funding from the government,[83-85,88,89] and three did not report the source of funding.[86,90,91]

The number of participants ranged from 36 to 191. Participants in all studies had a mean age of more than 65 years and a mean forced expiratory volume in 1 second (FEV_1) between 27% and 43%. Patients with terminal illness, lung cancer, cognitive impairment, mental illness, language barriers, and other major chronic diseases were excluded in most studies.

d) Mixed chronic diseases

Seven of the eight included studies with a mixed chronic disease population[92-98] compared home telemonitoring with usual care, and one compared telephone support with usual care.[99] In the home telemonitoring versus usual care comparison , there were four RCTs[94-96,98] and three observational studies.[92,93,97] Appendix 4d includes a description of the intervention and comparator in each study.

The length of follow-up ranged from six to 24 months. All studies were from the US. Six studies were funded by government,[92,93,95,97-99] one received funding from government and industry,[94] and one did not report the source of funding.[96]

The number of participants ranged from 37 to 1,401. The study participants had an overall mean age of more than 69 years and were predominately male. The study population consisted primarily of patients who had diabetes, heart failure, or COPD. Additional patient morbidities or comorbidities were cancer, chronic wound care, cardiovascular disease, stroke, hyperlipidemia, hypertension, respiratory disease, fractures, kidney disease, and osteoarthritis. Patients who had cognitive impairment, had no telephone line, had a life expectancy of less than six months, lived in a nursing home, or were enrolled in a similar study were excluded.

4.2.3 Data analyses and synthesis

The quality score and clinical outcomes of all included studies appear in Appendices 6a, 6b, 6c, and 6d. The QoL and patient satisfaction data appear in Appendices 7a, 7b, 7c, and 7d. The 78 included studies were grouped by chronic disease (diabetes, heart failure, COPD, and mixed chronic diseases) and by intervention (home telemonitoring and telephone support), and meta-analyses were performed. The health-related QoL results were not pooled. They were reviewed qualitatively because of variations in instruments and reported units. Because of existing clinical heterogeneity between studies, the results should not be interpreted as an estimate of expected benefits for all home telehealth interventions.

a) Diabetes

Twenty-six studies of diabetes were identified as being relevant in the review (21 home telemonitoring and five telephone support). Appendix 6a presents the quality scores, clinical outcomes, and conclusions for each study. Count data (for example, number of hospitalizations) were presented on a per patient basis to facilitate comparisons with other studies. A meta-analysis was conducted for studies with low statistical heterogeneity ($I^2 \leq 50$) that measured HbA1c levels.

Quality assessment

In the quality assessment of 17 RCTs, six were rated A,[31,35,38,39,45,47] two were rated B,[29,44] seven were rated C,[23,25,28,36,41,43,46] and two were rated D.[32,40] One observational study was rated B,[26] three were rated C,[22,30,34] three were rated D,[27,33,37] and two were rated E.[24,42]

Outcomes

Number of patients rehospitalized: Two observational studies[22,26] showed that fewer patients were rehospitalized in the home telemonitoring group compared with the usual care group: 117⁄391=30% versus 129⁄391=33%,[22] 95⁄445=21.3% versus 188⁄445=42.2%[26](Appendix 6a).

One RCT[47] reported a lower proportion of patients who were rehospitalized in the telephone support group compared with the usual care group (1/52=1.92% versus 2/49=4.08%).

Number of patients visiting the emergency department: One observational study reported that the number of patients visiting the emergency department was greater in the home telemonitoring group compared with the usual care group (234/391=59.8% versus 192/391=49.1%).[22] The other observational study[26] showed the reverse (278/445=62.5% versus 311/445=70%) (Appendix 6a).

One RCT[47] reported a higher proportion of patients in the usual care group who were rehospitalized compared with those in the telephone support group (0/52=0% versus 2/49=4.08%).

Number of patients visiting primary care clinics: Two observational studies[22,26] reported that the number of patients who visited primary care clinics was higher in the home telemonitoring group compared with the usual care group (188/391=48.1% versus 162/391=41.4%[22] and 283/445=63.6% versus 208/445=46.7%[26]).

No data were available for telephone support versus usual care.

Number of patients visiting specialist clinics: One observational study[22] showed that the number of patients who visited specialist clinics was greater in the home telemonitoring group (291/391=74.4%) compared with the usual care group (204/391=52.2%).
No data were available for telephone support versus usual care.

Number of hospitalizations: The total number of hospital admissions was lower following the one year post-enrolment period for home telemonitoring compared with the baseline in a pre-post study (25 versus 31)[27].

No data were available for telephone support versus usual care.

Bed days of care: Three observational studies[22,26,27] reported a lower mean number of BDOC per patient in the home telemonitoring group compared with the usual care group (15.6 versus 20.7,[22] 2.89 versus 5.89,[26] and 3.63 versus 8.98[27]).

No data were available for telephone support versus usual care.

Number of primary care visits: One observational study[28] reported a lower mean number of primary care visits per patient in the home telemonitoring group compared with the usual care group (4.2 versus 5.2).

No data were available for telephone support versus usual care.

Number of office visits: One RCT[38] showed a higher mean number of office visits per patient in the home telemonitoring group compared with the usual care group (8.9 versus 7.2).

No data were available for telephone support versus usual care.

HbA1c: The pooled result of 12 RCTs[23,25,28,29,31,32,37-41,100] showed that the HbA1c levels of patients in the home telemonitoring group were significantly lower than those of patients in the usual care group [weighted mean difference=−0.21; 95% confidence interval (CI) −0.35 to −0.08) (Table 2, Figure 3). The statistical heterogeneity was low between trials (I^2=16%). One observational study[42] reported a slightly lower HbA1c level in the home telemonitoring group compared with the usual care group (8.15 versus 8.25), and one observational study[33] found a higher HbA1c level in the home telemonitoring group (9.05±1.72 versus 8.03±1.0).

Because statistical heterogeneity among four RCTs[43,44,46,47] was high (I^2>50%), the results were not pooled. Two RCTs[46,47] reported mean lower HbA1c levels in the telephone support group compared with those in the usual care group (7.8±0.8 versus 8.9±1.0[46] and 7.6±1.1 versus 8.1±1.5[47]). Two RCTs[43,44] found a higher HbA1c level in patients who were using telephone support (8.8±0.9 versus 7.6±1.0[43] and 6.9±1.5 versus 6.6±1.1[44]).

Table 2: Meta-analyses Outcomes for Diabetes Home Telemonitoring HbA1c Levels

Number of Studies	Number of Patients	Statistical Heterogeneity; I^2, *p-value*	Mean Difference (95% CI)
12 RCTs	2,595	16; 0.29	−0.21 (−0.35, −0.08)

CI=confidence interval; HbA1c=glycosylated hemoglobin; RCTs=randomized controlled trials.

Quality of life and patient satisfaction: Eleven studies[23-26,29,30,36,38,44,45,101] reported QoL or patient satisfaction (Appendix 7a). In four studies,[23,24,30,47] most patients thought that home telehealth was better than usual care and that the system was reliable, simple, and user-friendly. Improvement in three of the eight SF-36V subscales was observed for role-physical, bodily pain, and social functioning after one year of home telehealth.[26]

Four studies[25,29,36,44] found no differences between groups in patient satisfaction or health-related QoL. Both groups expressed high satisfaction with their overall diabetic care. Although patients in the intervention group reported greater self-efficacy, fewer symptoms of depression, and fewer days in bed compared with those in usual care in one study, no intervention effect was observed on diabetes-specific health-related QoL.[45] One study reported fewer symptoms of poor glycemic control and significantly more satisfaction with home telehealth compared with usual care.[38] The home telehealth interventions were similar or favourable in terms of health related QoL or patient satisfaction compared with those in the usual care arm.

b) Heart failure

Thirty-five unique studies (20 home telemonitoring and 15 telephone support) pertaining to home telehealth for patients with heart failure were included in the clinical review. A description of the quality scores, outcomes for each treatment arm, and overall conclusions appear in

Appendix 6b. The results were pooled by intervention for health services utilization and clinical outcomes for studies with low statistical heterogeneity ($I^2 \leq 50$) (Tables 3a and 3b).

Quality assessment

In the quality assessment of the 21 RCTs, 10 were rated A,[49,52,54,64,69,70,73,76,79,81] six were rated B,[51,55,56,67,71,75] three were rated C,[48,72,78] and two were rated D.[57,58] Of the 14 observational studies, two were rated B,[50,63] three were rated C,[53,61,62] eight were rated D,[59,60,66,68,74,77,80,82] and one was rated E.[65]

Outcomes

Number of patients who were rehospitalized: Three RCTs[52,54,64] and one observational study[53] provided the data for a meta-analysis on the number of patients who were rehospitalized (all-cause) after home telemonitoring and usual care. The combined findings suggest that fewer patients were rehospitalized when home telemonitoring was compared with usual care [relative risk (RR)=0.78; 95% CI 0.66 to 0.92] (Figure 4). The statistical heterogeneity between studies was low (I^2=5%). The pooled numbers of patients who were rehospitalized were similar in a subgroup analysis of three RCTs[52,54,64] (RR=0.80; 95% CI 0.68 to 0.95) (Table 3a). The observational study[53] reported a smaller proportion of patients in the home telemonitoring group who were rehospitalized compared with patients receiving usual care (13⁄30 versus 36⁄51) (Appendix 6b).

One RCT[54] showed that a lower proportion of patients who used home telemonitoring were rehospitalized for cardiovascular reasons compared with those who received usual care (43/226=19% versus 73/229=31.9%).

For telephone support versus usual care, eight RCTs[52,69,70,72,73,75,79,81] and two observational studies[77,82] evaluated the number of patients who were rehospitalized (all-cause). The pooled outcomes of the RCTs[52,69,70,72,73,75,79,81] showed a fewer number of patients who were using telephone support were rehospitalized (RR=0.91; 95% CI 0.83 to 0.99) (Table 3a, Figure 5). The statistical heterogeneity between studies was low (I^2=21%). Two observational studies[77,82] also reported a lower proportion of patients in the telephone support group were rehospitalized compared with those in the usual care group (2⁄17 versus 4⁄5[77] and 3⁄20 versus 7⁄20[82]).

Five RCTs[70,73,75,79,81] reported the numbers of patients who were rehospitalized because of heart failure. The pooled result showed a difference that was favourable to the telephone support group compared with the usual care group (RR=0.77; 95% CI 0.66 to 0.89) (Table 3a, Figure 6). There was no statistical heterogeneity between studies (I^2=0%).

Mortality: Five RCTs[51,52,54,55,64] and one observational study[53] provided the data to meta-analyze the number of all-cause deaths among patients using home telemonitoring and those receiving usual care. The pooled number of all-cause deaths suggested that patients in the home telemonitoring group have a lower risk of death compared with those in the usual care group (RR= 0.65; 95% CI 0.49 to 0.87) (Table 3a, Figure 7). There was no statistical heterogeneity between studies (I^2=0%). A subgroup analysis of RCTs[51,52,54,55,64] also indicated a lower risk of mortality in the home telemonitoring group compared with the usual care group (RR= 0.61; 95% CI 0.45 to 0.83) (Table 3a).

One RCT[51] reported a lower heart failure-related mortality in the home telemonitoring group compared with the usual care group (2/67=3% versus 6/66=9.1%). Another RCT[54] reported a lower cardiovascular-related mortality among patients who were using home telemonitoring compared with those who received usual care (18/226 versus 29/229).

The pooled result of 10 RCTs[52,69-73,75,81,102,103] failed to show a difference in the number of all-cause deaths when telephone support and usual care groups were compared (RR=0.87; 95% CI 0.75 to 1.02) (Table 3a, Figure 8). There was no statistical heterogeneity between studies (I^2=0%).

Two RCTs[69,72] that studied heart failure-related mortality failed to find a difference in outcomes between the telephone support and usual care groups (RR=0.60; 95% CI 0.32 to 1.13) (Table 3a, Figure 9).

Table 3a: Meta-analyses Results for Heart Failure (relative risk)

Disease	Number of Studies	Intervention n/N	Usual Care n/N	Statistical Heterogeneity, I^2, *p-value*	Relative Risk (95% CI)
Heart failure: HTM					
Number of patients rehospitalized (all-cause)	3 RCTs 1 obs	172/463	191/405	5, 0.37	0.78 (0.66 to 0.92
	3 RCTs	159/433	155/354	0, 0.38	0.80 (0.68 to 0.95)
All-cause mortality	5 RCTs 1 cohort	75/645	103/615	0, 0.67	0.65 (0.49 to 0.87)
	5 RCTs	68/615	93/564	0, 0.80	0.61 (0.46 to 0.83)
Heart failure: TS					
Number of patients rehospitalized (all-cause)	8 RCTs	662/1,577	679/1,499	21, 0.6	0.91 (0.83 to 0.99)
Number of patients rehospitalized (HF-related)	5 RCTs	232/1,089	296/1,078	0, 0.50	0.77 (0.66 to 0.89)
All-cause mortality	10 RCTs	273/2,791	264/2,307	0, 0.74	0.87 (0.75 to 1.02)
HF-related mortality	2 RCTs	14/273	24/280	NA, 0.70	0.60 (0.32 to 1.13)
Number of patients who visit ED	2 RCTs	157/368	170/370	NA, 0.34	0.95 (0.82 to 1.10)

CI=confidence interval; ED=emergency department; HF=heart failure; HTM=home telemonitoring; NA=not applicable; obs=observational study; RCTs=randomized controlled trials; TS=telephone support.

Number of patients visiting an emergency department: Two RCTs[69,81] examined the number of patients who visited an emergency department and found no difference in risk between the telephone support and usual care groups (RR=0.95; 95% CI 0.82 to 1.11) (Table 3a, Figure 10).

One observational study[68] found that no patients in the telephone support group visited an emergency department because of conditions that are related to heart failure compared with one patient receiving usual care (0⁄17=0% versus 1⁄17=5.9%) (Appendix 6b).

Number of hospitalizations: The statistical heterogeneity among six RCTs[51,52,54,55,67,102] and five observational studies[50,60,61,65,66] was substantial (I^2>50%), so a meta-analysis was inappropriate. Eight studies reported a lower number of all-cause hospitalizations per patient in the home telemonitoring group compared with the usual care group (0.46 versus 1.54,[50] 0.33 versus 1.17,[51] 0.40 versus 0.62,[54] 0.7±1.7 versus 1.2±1.9,[102] 0.21 versus 0.35,[60] 0.2±0.5 versus 0.3±0.8,[61] 0.65 versus 1.29,[66] and 0.40 versus 0.59[67] respectively). Two RCTs[52,55] and one observational study[65] found higher rates of hospitalizations in the home telemonitoring group compared with the usual care group (0.95 versus 0.81,[52] 0.19±0.46 versus 0.20±0.30,[55] and 0.46 versus 0.10[65] respectively).

The pooled result of 10 RCTs[52,69,70,75,76,78,79,81,102,103] failed to indicate a difference in all-cause hospitalization rate between the telephone support and usual care groups (rate ratio=0.90; 95% CI 0.80 to 1.01) (Table 3b, Figure 11). Some statistical heterogeneity was present between studies (I^2=28%) (Table 3b). Two observational studies[74,80] reported a lower mean number of all-cause hospitalizations per patient in the telephone support and usual care groups (1.9±3.8 versus 3.4±6.7[74] and 0.4 versus 0.8[80]).

Eight RCTs[69,70,75,76,78,79,102,103] provided data for a meta-analysis of the number of hospitalizations related to heart failure. The pooled results showed that patients in the telephone support group had a lower rate of heart failure-related hospitalizations than those in the usual care group (rate ratio=0.78; 95% CI 0.63 to 0.96). There was some statistical heterogeneity between studies (I^2=39%) (Table 3b, Figure 12).

Number of emergency department visits: Because the statistical heterogeneity among four RCTs[51,52,64,102] and five observational studies[53,60,61,65,66] was high (I^2≥50%), a meta-analysis was not deemed to be suitable. Seven studies found a lower number of mean all-cause emergency department visits per patient in the home telemonitoring group compared with the usual care group (0.02 versus 0.18,[51] 0.03 versus 0.22,[53] 0.7±1.4 versus 1.8±2.5,[102] 0.04 versus 0.22,[60] 0.34±0.6 versus 0.38±0.6,[64] 0.15 versus 0.30,[65] and 0.17 versus 0.63[66]). One RCT[52] reported a higher mean number of emergency department visits in the home telemonitoring group (0.37 versus 0.09), and one observational study[61] found no difference between both groups (0.05±0.2 versus 0.05±0.2).

One RCT[102] found a lower mean number of heart failure-related emergency department visits per patient in the home telemonitoring group compared with the usual care group (0.1±0.3 versus 0.7±0.9).

The outcomes of four RCTs[69,78,81,102] were not pooled because of high statistical heterogeneity between trials (I^2>50%). Three RCTs found a lower mean number of all-cause emergency department visits per patient in the telephone support group compared with the usual care group (3.2 versus 3.5[69], 0.7±1.4 versus 1.8±2.5[102], and 0.3 versus 0.51[81]). One RCT[78] reported a higher mean rate of emergency department visits in the telephone support group compared with the usual care group (0.14±0.45 versus 0.11±0.34)[78].

The outcomes of three RCTs[71,81,102] were not pooled, because the statistical heterogeneity between studies was high (I^2>50%). Two RCTs[81,102] found a lower mean number of heart failure-related emergency department visits per patient in the telephone support group compared with the usual care group (0.2±0.4 versus 0.7±0.9[102] and 0.14 versus 0.36[81]). The other trial[71] reported a higher mean number of emergency department visits per patient in the telephone support group compared with the usual care group (0.06 versus 0.05).

Bed days of care: Four observational studies[50,60,63,67] reported a lower mean all-cause BDOC per patient in the home telemonitoring group compared with the usual care group (2.19 versus 8.08,[50] 1.21 versus 1.97,[60] 1.65±5.4 versus 8.63±9.6,[63] 2.11 versus 3.93[67]). One RCT[52] reported a higher mean BDOC in the home telemonitoring group (10.9) compared with the usual care group (9.6).

Two RCTs[49,67] reported a lower mean heart failure-related BDOC in the home telemonitoring group compared with the usual care group (0.46 versus 0.97[49] and 2.69 versus 3.75[67]). One observational study[62] found a lower mean heart failure-related BDOC per patient in the home telemonitoring arm compared with the usual care arm (5.87 versus 13.75).[62]

Because there was substantial statistical heterogeneity among seven RCTs,[52,70,71,75,78,79,81] (I^2>50%), the outcomes were not pooled. Five RCTs reported a lower mean BDOC per patient in the telephone support group compared with the usual care group (13.3 versus 14.5,[70]10.2±16.8 versus 15.2±17.5,[75] 3.5±6.6 versus 4.8± 8.3,[78] 6.33±9.4 versus 7.41±8.9,[79] and 4.48 versus 7.96[81]). One RCT[52] found that the telephone support group had a greater mean BDOC per patient (14.8 versus 9.6). The other RCT[71] reported no difference in outcomes between both groups (0.35 versus 0.34). Two observational studies[74,80] reported a lower mean number of all-cause BDOC in the telephone support group compared with the usual care group (4.8±10 versus 17±38[74] and 0.8 versus 9.5[80]).

Three RCTs[75,78,104] compared the heart failure-related BDOC for patients using telephone support with those receiving usual care. The outcomes were not pooled because the statistical heterogeneity between trials was substantial (I^2>50%). Two RCTs reported a lower mean heart failure-related BDOC per patient in the home telemonitoring group compared with the usual care group (4.1±6.4 versus 15.2±17.5[75] and 1.1±3.1 versus 2.1±4.6[78]). One RCT[79] found no difference in the mean BDOC per patient between groups (3.65±7.8 versus 3.40±7.1).

Number of primary care visits: One RCT[52] reported a higher mean number of primary care visits per patient in the home telemonitoring group compared with the usual care group (2.79 versus 1.40). One observational study[65] reported a lower mean number of primary care visits per patient in the home telemonitoring group compared with the usual care group (0.85 versus 1.00). Because of high statistical heterogeneity among three RCTs[52,78,81] (I^2>50%), the study outcomes were not pooled. One RCT[78] reported a lower mean number of primary care visits per patient in the telephone support group compared with the usual care group (5.63±3.6 versus 6.17±4.87). The other two RCTs found a higher mean number of primary care visits per patient in the telephone support group (3.54 versus 1.40[52] and 6.7 versus 6.6[81]).

One RCT[81] found a lower rate of heart failure-related primary care visits in the telephone support group compared with the usual care group (1.6±1.44 versus 1.91±1.71).

Number of specialist visits: One RCT[52] reported a higher mean rate of heart failure-related specialist visits in the home telemonitoring group compared with the usual care group (0.6 versus 0.4).

One RCT[52] found a higher mean rate of heart failure-related specialist visits in the telephone support group (0.69 versus 0.4).

Number of office visits: One RCT[52] reported a higher mean rate of office visits (including visits to the family physician, specialist, or nurse) in the home telemonitoring group compared with the usual care group (4.0 versus 2.2).

Two RCTs[52,71] reported a higher mean number of office visits per patient in the telephone support group compared with the usual care group (4.8 versus 2.2[52] and 5.0 versus 4.92[71]).

Number of home care visits: Two RCTs[52,102] reported a higher mean number of home care visits per patient in the home telemonitoring group compared with the usual care group (1.8 versus 0.8[52] and 2.3± 0.6 versus 2.0±0.0[102]). One observational study[61] reported a lower mean rate of home care visits in the home telemonitoring group compared with the usual care group (5.8±1.6 versus 8.2±2.4).

One trial reported a higher rate of home care visits in the telephone support group compared with the usual care group (2.3 versus 0.8).[52] Another trial found no difference between groups (1.9± 0.3 versus 2.0±0.0).[102] One observational study[77] reported a lower mean number of home care visits per patient in the telephone support group compared with the usual care group (0.43 versus 2.48).

Table 3b: Meta-analyses Results for Heart Failure Telephone Support (rate ratios)

	Number of Studies	Intervention	Usual Care	Statistical Heterogeneity, I^2, *p-value*	Rate Ratio (95% CI)
		Events/Person-Years	Events/Person-Years		
All-cause hospitalizations	10 RCTs	943/1,735	1,009/1,253	28, 0.19	0.90 (0.80 to 1.01)
HF-related hospitalization	8 RCTs	308/556	420/602	39, 0.11	0.78 (0.63 to 0.96)

CI=confidence interval; HF=heart failure; RCTs=randomized controlled trials.

Quality of life and patient satisfaction: Twenty-two studies[48-50,55-58,61-64,67,68,70,73,74,76-80,82] reported QoL or patient satisfaction (Appendix 7b). Twelve studies[48,49,55-58,64,68,70,74,79,82] reported no significant differences between groups in QoL and patient satisfaction. Eight studies[50,61,62,67,73,76-78] reported a better QoL, higher satisfaction, or higher adherence to drug treatment for patients in the intervention group compared with the usual care group. Two studies[63,80] that had no usual care data reported that patient satisfaction and patient acceptance of the home telehealth program was high.

Compared with usual care, the home telehealth interventions were similar or favourable in terms of QoL, adherence to treatment, compliance, and patient satisfaction.

c) Chronic obstructive pulmonary disease

Nine studies (four home telemonitoring and five telephone support) were included in our clinical review. The quality scores, outcomes, and conclusions of these studies appear in Appendix 6c. Health services utilization and clinical outcomes for studies with low statistical heterogeneity ($I^2 \leq 50$) were pooled by intervention (Tables 4a and 4b).

Quality assessment

In the quality assessment of the six RCTs, two were rated A,[87,88] three were rated B,[84,90,91] and one was rated D.[89] One observational study was rated B,[85] one was rated C,[83] and one was rated D.[86]

Outcomes

Number of patients rehospitalized: One RCT[84] reported a lower proportion of patients in the home telemonitoring group who were rehospitalized compared with the usual care group (31/67=46.3% versus 59/90=65.6%).

One RCT[87] reported a lower proportion of patients in the telephone support group who were rehospitalized compared with the usual care group (31/96=32.2% versus 48/95=50.5%).

Mortality: One RCT[84] reported a higher mortality among patients who were using home telemonitoring compared with those who were receiving usual care (14/67=20.9% versus 15/90=16.7%).

Three RCTs[87,88,90] provided data for a meta-analysis on the number of deaths. The pooled result showed a higher risk of mortality in the telephone support group compared with the usual care group, although there was no statistical significance (RR=1.21; 95% CI 0.85 to 1.79) (Table 4a, Figure 13). There was no statistical heterogeneity between studies (I^2=0%).

Table 4a: Meta-analyses Results for COPD Telephone Support (relative risk)

	Number of Studies	Intervention n/N	Usual Care n/N	Statistical Heterogeneity, I^2, *p-value*	Relative Risk (95% CI)
All-cause mortality	3 RCTs	44/221	40/247	0, 0.74	1.24 (0.85 to 1.79)

CI=confidence interval; COPD=chronic obstructive pulmonary disease; RCTs=randomized controlled trials.

Number of hospitalizations: The pooled result of one RCT[84] and two observational studies[83,85] showed a reduced rate of hospitalization in the home telemonitoring group compared with the usual care group (rate ratio: 0.69; 95% CI 0.44 to 1.05), which was significant (Table 4b, Figure 14). There is statistical heterogeneity between studies (I^2=49%). The RCT[84] suggests that there is a reduced rate of hospitalizations for patients using home telemonitoring (rate ratio=0.67; 95% CI 0.49 to 0.92).

The statistical heterogeneity among five RCTs[87-91] was high (I^2>50%), so a meta-analysis was not suitable. Lower mean numbers of hospitalizations per patient were reported across all trials for telephone support and usual care groups (0.96 versus 1.76,[87] 1.5±2.6 versus 2.1±3.1,[88] 2.1 versus 2.6,[89] 0.5±0.86 versus 1.29±1.7,[90] and 0.6±1.0 versus 1.1±1.3[91]).

Bed days of care: One observational study reported a higher mean number of BDOC in the home telemonitoring group compared with the usual care group (13.5 versus 7.3).[83] Two observational studies reported a lower mean number of BDOC per patient in the home telemonitoring group compared with the usual care group (6.6±24.0 versus 7.46±19.9[85] and 3.6 versus 17.5[86]).

The statistical heterogeneity among three RCTs[87,90,91] was substantial (I^2>50%), so a meta-analysis was not appropriate. Two RCTs reported a lower mean BDOC in the telephone support groups compared with the usual care groups (7.2±19.5 versus 12.5±21.2[87] and 7.43±15.6 versus 18.2±24.55[90]). The other RCT[91] found a higher mean number of BDOC in the telephone support group compared with the usual care group (19.6±2.5 versus 17.3±4.4).

Number of emergency department visits: One RCT[84] reported a lower mean number of emergency department visits per patient in the home telemonitoring group compared with the usual care group (0.36±0.98 versus 0.54±1.12).

Because of substantial statistical heterogeneity among three RCTs[87,90,91] (I^2>50%), a meta-analysis was not conducted. All trials reported a lower mean number of emergency department visits per patient in the telephone support group compared with the usual care group (1.58 versus 2.47,[87] 0.45±0.83 versus 1.58±1.96,[90] and 0.1±0.3 versus 0.4±0.7[91]).

Number of primary care visits: One RCT[87] reported a lower mean number of primary care visits per patient in the telephone support group compared with the usual care group (0.48 versus 1.18). No data were available for home telemonitoring versus usual care.

Number of specialist visits: One RCT[87] reported a lower mean number of specialist visits per patient in the telephone support group compared with the usual care group (0.25 versus 0.27). No data were available for home telemonitoring versus usual care.

Number of office visits: One observational study[86] reported a lower mean number of office visits per patient in the home telemonitoring group compared with the usual care group (4.8 versus 8.7). Another observational study[85] found a greater mean number of office visits per patient in the home telemonitoring group (3.23±2.2 versus 2.3±1.3).
One RCT[91] reported a lower mean number of office visits in the telephone support group compared with the usual care group (5.0 versus 6.0).

Number of home care visits: One observational study[83] reported a lower mean number of home care visits per patient in the home telemonitoring group compared with the usual care group (4.2 versus 7.5).

No data were available for telephone support versus usual care.

Table 4b: Meta-analyses Results for COPD Home Telemonitoring (rate ratio)					
	Number of Studies	Intervention	Usual Care	Statistical Heterogeneity, I^2, *p-value*	Rate Ratio (95% CI)
		Events/Person -Years	Events/Person -Years		
Number of hospitalizations	1 RCT 2 obs	101/107	168/123	49, 0.14	0.69 (0.44 to 1.05)
	1 RCT	61⁄68	120⁄90	NA	0.67 (0.49 to 0.92)

CI=confidence interval; COPD=chronic obstructive pulmonary disease; NA=not applicable; RCT=randomized controlled trial.

Quality of life and patient satisfaction: Five studies reported QoL or patient satisfaction (Appendix 7c). No differences between groups in QoL or patient satisfaction were found in two studies.[96,98] Three studies reported that home telehealth improved functional independence,[92] mental health status,[95] and QoL.[97]

d) Mixed chronic diseases

Eight studies (seven home telemonitoring and one telephone support) on mixed chronic diseases were identified as relevant in the review. Appendix 6d presents the quality, clinical outcomes, and conclusions for each study. Because the studies cover diverse patient populations, no attempt was made to conduct a meta-analysis. Instead, the results were reviewed qualitatively.

Quality assessment

In the quality assessment of five RCTs, one was rated B,[98] and four was rated C.[94-96,99] Of the three observational studies, one was rated C,[93] and two were rated D.[92,97]

Outcomes

Number of patients rehospitalized: One RCT[94] reported a lower proportion of patients in the home telemonitoring group who were rehospitalized compared with those in the usual care group (6⁄34 versus 8⁄19).

No data were available for telephone support versus usual care.

Mortality: One RCT[94] reported a lower mortality in the home telemonitoring group compared with the usual care group (7⁄34 versus 5⁄19).

One RCT[99] reported a lower mortality in the telephone support group compared with the usual care group (51⁄377 versus 90⁄404).

Number of hospitalizations: One observational study[93] reported a lower number of hospitalizations per patient for the home telemonitoring group compared with the usual care group (0.5±1.1 versus 0.9±1.5). One RCT[95] showed a lower rate of hospitalizations in the home telemonitoring group compared with the usual care group (0.67±1.03 versus 1.26±2.00).

No data were available for telephone support versus usual care.

Bed days of care: Two RCTs[95,98] and two observational studies[93,97] reported a lower rate of BDOC in the home telemonitoring group compared with the usual care group (2.83±4.12 versus

7.11±12.86,[95] 1.8±3.3 versus 5.11±10.54,[98] 5.1±11.4 versus 6.1±9.2,[93] and −68% versus +32%[97] respectively).

No data were available for telephone support versus usual care.

Number of emergency department visits: Two RCTs and one observational study reported a lower mean number of emergency department visits per patient in the home telemonitoring group compared with the usual care group (1.00±1.33 versus 2.11±2.89,[95] 5.39±5.50 versus 5.69±6.01,[98] and 0.92±1.69 versus 1.08±1.33[93]). One observational study reported a decrease in the number of emergency department visits per patient in the home telemonitoring group compared with the usual care group (−66% versus +22%).[97]

No data were available for telephone support versus usual care.

Number of primary care visits: One RCT[95] reported a lower mean number of primary care visits per patient in the home telemonitoring group compared with the usual care group (3.39±3.85 versus 3.89±5.03).

No data were available for telephone support versus usual care.

Number of specialist visits: One RCT[95] reported a lower mean number of specialist visits per patients in the home telemonitoring group compared with the usual care group (2.06±2.49 versus 2.47±2.61).

No data were available for telephone support versus usual care.

Number of office visits: Two RCTs and one observational study reported a lower mean number of office visits per patient in the home telemonitoring group compared with the usual care group (29.06±30.11 versus 38.89±28.99,[95] 14.83±11.28 versus 14.96±15.09,[98] and 5.5±3.3 versus 6.4±4.0[93]). One observational study reported a decrease in the number of office visits per patient in the home telemonitoring arm compared with the usual care arm (−4% versus +19%)[97]).

No data were available for telephone support versus usual care.

Number of home care visits: One RCT[96] reported a lower mean number of home care visits per patient for a diverse patient population (including those with a diagnosis of CHF, COPD, cerebral vascular accident, cancer) in the home telemonitoring group compared with those receiving usual care (9.8 versus 11.1). Another RCT[98] reported a higher number of home care visits per patient for chronically ill patients in the home telemonitoring group compared with the usual care group (2.00±4.60 versus 1.81±5.66).

Quality of life and patient satisfaction: Five studies reported QoL or patient satisfaction (Appendix 7d). No differences between groups were found in two studies.[96,98] Three studies reported that home telehealth improved functional independence,[92] mental health status,[95] and QoL.[97]

e) Summary

Table 5 summarizes the clinical outcomes of home telemonitoring and telephone support in the management of diabetes, heart failure, COPD, and mixed chronic diseases.

Table 5: Clinical Outcomes

Chronic Disease	Clinical Outcomes
Diabetes	• Home telemonitoring provided better glycemic control (lower HbA1c levels) for patients with diabetes than usual care. • Home telemonitoring appears to reduce rehospitalization and bed days of care, while use of primary care clinics and specialist clinics is higher in home telemonitoring than usual care. • Evidence for health services utilization was limited for telephone support. • Health-related QoL and patient satisfaction from home telehealth appears to be similar or better compared with usual care. • No differences in management strategies for type 1 and type 2 diabetes were mentioned in included studies.
Heart failure	• Home telemonitoring and telephone support were shown to reduce rates of rehospitalizations, emergency department visits, and bed days of care for all-cause or heart failure-related events. • Home telemonitoring was shown to reduce mortality. Telephone support showed no difference compared with usual care. • Home telemonitoring and telephone support were found to increase number of non-hospitalized health care visits including primary care visits, specialist visits, and home care visits. • Health-related QoL and patient satisfaction of patients using home telehealth were comparable or better than usual care.
COPD	• Home telemonitoring and telephone support were found to reduce rates of rehospitalization and emergency department visits, while outcomes on bed days of care among patients with COPD varied across studies. • Mortality rate was high in home telemonitoring and telephone support compared with usual care. • Evidence with respect to non-hospital-related health care visits was limited. • Health-related QoL of COPD patients between home telehealth and usual care was comparable.
Mixed	• Home telemonitoring helped to reduce all health services utilization in patient populations with chronic diseases compared with usual care. • Home telemonitoring and telephone support were found to reduce mortality. • No substantial difference in health-related QoL and patient satisfaction was found between home telehealth and usual care.

COPD=chronic obstructive pulmonary disease; HbA1c=glycosylated hemoglobin; QoL=quality of life.

4.2.4 Systematic reviews and meta-analyses of home telehealth

Eighteen systematic reviews and one meta-analysis were identified in our literature search (Table 6). The reviews covered an array of patient populations with chronic illnesses. Seventeen systematic reviews[8,105-120] and one meta-analysis[121] found home telehealth to be clinically effective in disease management. One systematic review[122] found no improvement in clinical outcomes in the home telehealth intervention and usual care groups. The magnitude of effectiveness is debatable because the evidence is limited.

Table 6: Systematic Reviews and Meta-analyses of Home Telehealth for Chronic Disease Management		
Authors	**Number of Studies and Patients**	**Objective and Conclusions**
DelliFraine and Dansky[105]	29 studies	Identify studies on effect of home telehealth on clinical care outcomes. Overall, meta-analysis indicated that telehealth positively affects clinical outcomes of care, including different patient populations.
Garcia-Lizana and Sarria-Santamaria[122]	24 studies	Measure clinical-effectiveness of interventions using ICT and usual care for managing chronic diseases. Overall, ICT applications did not show improvement in clinical outcomes, although no adverse events were reported. ICTs used in detection and follow-up of cardiovascular diseases provided better clinical outcomes, mortality reduction, and lower health services utilization. Systems used for improving education and social support also shown to be effective. Evidence about clinical benefits of ICTs for managing chronic diseases was limited.
Verhoeven et al.[106]	39 studies	Study benefits of teleconsultation and videoconferencing on diabetes care. Selected studies suggested that teleconsultation and videoconferencing were practical, cost-effective, and reliable ways to deliver health care services to patients with diabetes. Diversity in study design and reported results made a strong conclusion premature.
Bowles and Baugh[107]	40 studies	Summary and critique of published empirical evidence about effects of telehomecare in older adult patients with chronic illness. Research suggested that home care using communication and monitoring technology is feasible and acceptable to patients and providers. Addition of telehomecare technology seemed to improve health among patients with chronic illness, most often heart failure, diabetes, and chronic wounds. Over the long term, cost for management of chronic illness seemed to decrease with use of telehomecare.
Barlow et al.[108]	98 studies (68 RCTs and 30 observational studies) approximately 150,000 patients	Systematic review of home telecare for frail elderly people and for patients with chronic conditions. Based on evidence, most effective telecare interventions seemed to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). Cost-effectiveness of telecare interventions was less certain. Insufficient evidence about effects of home safety and security alert systems.
Paré et al.[8]	65 studies	Systematic review of nature and magnitude of outcomes associated with telemonitoring of 4 types of chronic illnesses: pulmonary conditions, diabetes, hypertension, and cardiovascular diseases. Home telemonitoring of chronic diseases may be a promising patient management approach that produces accurate and reliable data, empowers patients, influences their attitudes and behaviours, and potentially improves their medical conditions. Future studies need to build evidence related to clinical

Table 6: Systematic Reviews and Meta-analyses of Home Telehealth for Chronic Disease Management		
Authors	**Number of Studies and Patients**	**Objective and Conclusions**
		effects, cost-effectiveness, impacts on services utilization, and acceptance by health care providers.
Clark et al.[109]	14 RCTs 4,264 patients	Determine whether remote monitoring (structured telephone support of telemonitoring) without regular clinic or home visits improves outcomes for patients with CHF. Programs for chronic heart failure had positive effect on clinical outcomes in community dwelling patients with CHF.
Bensink et al.[110]	130 studies	Identify studies in home telehealth that compared home telehealth intervention with usual care in terms of administrative changes, patient management decisions, patient outcomes, caregiver outcomes, economic impact, or social impact on patients. 17% of home care projects reported sufficient economic data for appraisal. Evidence exists for clinical-effectiveness of home telehealth in diabetes, mental health, high risk pregnancy monitoring, heart failure, and cardiac disease.
Martinez et al.[111]	42 studies	Assess value of home monitoring for heart failure patients. Evaluation of articles showed that home telemonitoring in heart failure patients is viable, given that it appears to be technically effective for following patients remotely; it appears to be easy to use; it is widely accepted by patients and health professionals; and it appears to be economically viable.
Jaana and Paré[112]	17 studies	Provide systematic review on diabetes home telemonitoring and informational, clinical, behavioural, structural, and economical impact. Close management of diabetic patients through telemonitoring showed significant reduction in HbA1c and complications, good receptiveness by patients, and patient empowerment and education; however, magnitude of effects remains debatable.
Kleinpell and Avitall[113]	12 studies	Review of use of telehealth and telemanagement in heart failure, including discussion of telehealth modalities and research on telehealth for heart failure management. While several studies confirmed benefits of telemanagement for patients with heart failure, additional research is warranted.
Whellan et al.[114]	19 RCTs	Assess effectiveness of disease management programs in reducing hospitalization and mortality in patients with heart failure. Results of analysis indicated that heart failure disease management is an intervention that could significantly decrease hospitalization for patients with heart failure. Because of differences in types of strategies and variety of health care settings in which they were evaluated, further studies on heart failure disease management programs with multiple participating centres are required.
Holland et al. [115]	30 studies	Determine impact of multidisciplinary interventions on hospital admission and mortality in patients with heart failure. Multidisciplinary intervention for heart failure reduced hospital admission and all-cause mortality. Authors concluded that most effective interventions were delivered at least partly in the home.

Table 6: Systematic Reviews and Meta-analyses of Home Telehealth for Chronic Disease Management		
Authors	**Number of Studies and Patients**	**Objective and Conclusions**
Taylor et al.[116]	9 RCTs	Determine effectiveness of innovations in management of COPD involving nurses (including telephone support). Little evidence to support widespread implementation of nurse led management interventions for COPD, but data too sparse to exclude clinically relevant benefit or harm from such interventions.
Montori et al.[117]	6 trials	Determine efficacy of telecare (modem transmission of glucometer data and clinician feedback) to support intensive insulin therapy in patients with type 1 diabetes and inadequate glycemic control. Meta-analysis of 7 randomized trials of adult patients with type 1 diabetes found 0.4% difference (95% CI 0 to 0.8) in HbA1c mean change from baseline between telecare and usual care groups. Telecare is associated with small effects on glycemic control in patients with type 1 diabetes on intensive insulin therapy but with inadequate glycemic control.
Balas et al.[118]	40 trials	Identify impact of automated information interventions on diabetes care and patient outcomes and to enable this knowledge to be incorporated into diabetes care practice. Computerized knowledge management is becoming a vital component of quality diabetes care. Prompting follow-up procedures, computerized insulin therapy adjustment using home glucose records, remote feedback, and counselling have documented benefits in improving diabetes-related outcomes.
McAlister et al.[121]	29 trials 5,039 patients	Determine whether multidisciplinary strategies (including telephone follow-up or telemonitoring) improve outcomes for heart failure patients. Multidisciplinary strategies for disease management for patients with heart failure reduce heart failure-related hospitalizations. Those programs that involve specialized follow-up by multidisciplinary team reduced mortality and all-cause hospitalizations.
Louis et al.[119]	24 studies (6 RCTs and 18 observational studies)	Review literature on application of telemedicine in management of heart failure. Telemonitoring may have important role as part of effective health care delivery strategy for patients with heart failure. Adequately powered multicentre, randomized usual care-led trials are required to further evaluate potential benefits and cost-effectiveness of intervention.
Hersh et al.[120]	25 studies	Evaluate efficacy of home-based and office or hospital-based telemedicine interventions for health outcomes. Despite widespread use of telemedicine in virtually all areas of health care, evidence about benefits of telemedicine is limited. More randomized usual care-led trials must be done to determine where its use is most effective.

CHF=congestive heart failure; COPD=chronic obstructive pulmonary disease; HbA1c=glycosylated hemoglobin; ICT=information and communication technologies; RCTs=randomized controlled trials.

5 ECONOMIC REVIEW AND ANALYSIS

5.1 Review of Economic Studies

5.1.1 Methods

a) Literature search strategy

The literature search for the economic review, which was developed by the information specialist with input from the project team, including the lead health economist (DC), was peer-reviewed by an internal information specialist who was not involved with the project. Results were limited to articles published from 1998 to 2008), with no language restrictions (Appendix 1).

The following bibliographic databases were searched through the Ovid interface: MEDLINE, MEDLINE Daily Update, MEDLINE In-Process & Other Non-Indexed Citations, BIOSIS Previews, and EMBASE. Parallel searches were run in PubMed, The Cochrane Library, CRD Health Technology Assessment (HTA), plus the Health Economic Evaluations Database (HEED) and the CRD NHS Economic Evaluation Database (NHS EED). The search strategy included standard controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings) and keywords. The main search concept was home telehealth. Methodological filters were applied to limit retrieval to cost analyses and other economic studies. Results on chronic diseases (including diabetes, COPD, and CHF) were flagged by a focused search. Appendix 1 shows the search strategies. OVID AutoAlerts and PubMed MyNCBI were set up to send monthly updates for new literature. Monthly searches were also performed in The Cochrane Library, HEED, and CRD.

The reference lists of all included studies were scanned to identify additional potentially relevant studies. Grey literature was identified by searching the websites of health technology assessment and related agencies, professional associations, and other specialized databases. Non-peer reviewed studies were not considered in the review. Such studies that are relevant to the Canadian system are considered in Appendix 11. Internet search engines such as Google were used to search for web-based information. Conference proceedings, references in relevant articles, and appropriate expert and agency contacts supplemented the search.

b) Selection criteria

The inclusion criteria for this review were:

Study Design: economic evaluation comparing home telehealth with an alternative care strategy not including home telehealth. Economic evaluations included cost-minimization analyses, cost-effectiveness analyses, cost-utility analyses, or cost-benefit analyses; or a comparison of the costs of a strategy comparing home telehealth with an alternative care strategy not including home telehealth, with the implicit assumption that the strategies including home telehealth were no less effective than the alternatives.

Patient population: studies with at least one of the following chronic diseases: diabetes, heart failure, or COPD.

Intervention: home telehealth, as defined in the clinical review section.

c) Selection method

The literature search strategy identified 1,567 studies. The abstracts and titles of these studies were reviewed by two reviewers (DC and KC). The papers that were identified by either reviewer as being potentially relevant were examined. Full papers and reports for the studies that were identified were examined by both reviewers. Studies were included for formal review if both reviewers thought that they were relevant. In cases of disagreement, consensus was reached.

d) Data extraction strategy

The following data were extracted for each included study by one reviewer (DC or KC) and verified by the other reviewer:

- Study author and reference number
- Country in which study was conducted
- Disease area
- Details of patient population included in study
- Details of all strategies included in analysis, including current care strategy and strategy incorporating home telehealth
- Form of analysis (cost-benefit analysis, cost-utility analysis, cost-effectiveness analysis, cost-minimization analysis, or cost analysis)
- Types of health care resources included
- Perspective of study (societal or health care system)
- Study design (such as RCT, before and after study, and case usual care study)
- Time horizon of study
- Summary of study results
- Additional comments relating to design and reporting of economic evaluation
- Assessment of study quality.

e) Study quality

It was necessary to assess the quality of previous economic studies of home telehealth to determine their suitability in terms of aiding in the decision making about the cost-effectiveness of programs. One reviewer (DC) assessed each included study for quality.

The study quality was assessed through a 10-point scale, which was developed based on criteria that were identified in three articles on the conduct of economic evaluation in telemedicine (Mair[123], McIntosh,[124] and Whitten[125]) (Appendix 8a). The 10-point checklist is similar to that suggested by Drummond et al.[126] for assessing the study quality of economic evaluations in general; but in this context, it is more specific to the requirements for studies in home telehealth.

The questions in the checklist (Appendix 8b) were phrased for a yes or no answer. For each study, the number of questions with a positive response was recorded. This number should not be interpreted as a quality score, because the importance of each question is not equal. For example, the need for discounting in this context is limited and less important than the need for data to come from a study with a high-quality design.

5.1.2 Results

a) Number of studies identified

The results of the literature search appear in Figure 15. The total number of studies that were reviewed includes duplicates (the same paper identified through different databases) and duplicate publications (the same studies reported in more than one publication). After a review of 150 articles, 22 studies were found to be relevant for inclusion in the literature review.

In addition, three non-peer-reviewed reports of Canadian evaluations of home telehealth were examined using a more narrative approach than was used for the peer-reviewed articles. Appendix 9 shows the excluded economic studies.

b) Characteristics of published studies

The characteristics of each study appear in Appendix 10.

Country

Most of the studies (17) came from the US. There was one study from each of Germany,[23] Spain,[90] Italy,[127] the UK,[128] and Canada.[129]

Disease area

Most of the studies (12) focused on home telehealth for heart failure patients. Five studies focused on diabetes patients, and three focused on COPD patients. The two other studies included patients with a variety of diseases (all included diabetes, COPD, or heart failure patients).

Patient population

Those studies that focused on heart failure had a variety of inclusion criteria. One study[130] included patients with coronary heart disease and those with heart failure. Three studies[61,66,131] required patients to have moderate or severe heart failure. Six studies[61,66,76,78,79,132] required recent discharge from hospital or frequent emergency department visits. One study[102] required patients to be at least 40 years old, while another[79] included only Hispanics.

All five studies on diabetes were of patients with different baseline criteria: adolescents,[25] patients on intensive insulin therapy,[23] indigent or economically disadvantaged patients with diabetes,[133] elderly patients with diabetes who were recently discharged from hospital,[134] and patients with type 2 diabetes.[128]

Two of the three COPD studies[90,127] were of patients requiring long-term oxygen therapy, while the other COPD study[129] focused on patients with severe disease post discharge from their first hospitalization.

For those studies examining multiple diseases, one[135] required patients to have at least three chronic or complex conditions and to have received home care for at least six months. In the other study,[96] patients had to have one of CHF, COPD, diabetes, stroke, or cancer; or require wound care.

Comparators
The non-home telehealth strategy varied in terms of whether it involved a specified organized home care or other support program[25,49,50,61,96,129,131,134,135] or primary care as directed by the physician, which may or may not have included home care.[23,66,71,74,76,78,79,90,102,127,128,130,133]

The home telehealth interventions tended to be complex, often with more than one facet of patient management changed in the intervention arm of the study. All but one home telehealth strategy[128] involved augmented interactions between the patient and a nurse.

Most studies of patients with heart failure involved regular telephone monitoring of patients by nurses,[49,50,71,76,78,79,102] with one also incorporating video interactions.[102] Other studies involved a system whereby information on patients was sent by telephone[74] or computer link-up[61,130,131,136] to nursing staff for monitoring of the patient's condition.

Three of the five diabetes studies[23,25,133] evaluated different systems whereby patient data were relayed to a nurse, physician, or diabetes centre with advice then being provided to the patient by telephone. One study[134] evaluated a program of video visits between patients and home care nurses, and the other study evaluated a call station that was managed by non-health care professionals.[128]

Form of analysis
One study was a formal full economic evaluation (a cost-utility study[128]). The others were cost-analyses or cost-minimization analyses. In the cost-utility analysis, the long-term costs and utilities were derived from a US study and then converted to the UK context, with no information being given on the range of costs that were included. Thus, no published study of home telehealth involved a formal assessment of utilities or the program's impact on long-term outcomes.

Resources included
Most studies involved an assessment of the costs of health care resources such as hospitalizations, outpatient care, and emergency department visits. Most included costs that were required to establish a home telehealth program. Most did not involve a consideration of all health care resources. Two[23,25] incorporated patient based costs. In four studies[74,128,131,135] it was unclear what health care resources were included. Seven studies failed to adequately incorporate the costs of the home telehealth intervention.[66,71,74,79,102,131,133]

Perspective
Most studies failed to specify the perspective that was adopted. For this report, the perspective was interpreted based on the resources that were included or the methods of costing. Two studies adopted a societal perspective.[23,25] Ten studies[49,50,61,66,74,78,79,102,131,135] from the US adopted the perspective of a specific health insurance provider. The other studies adopted a health care system perspective.

Study design
Fourteen studies were based on data from randomized trials.[23,25,49,69,71,78,79,90,96,102,128,130,134,135] Four studies were based on data from a case study,[61,66,129,131] and four were based on data from a before-and-after study.[50,74,127,133]

Time horizon
The time horizon of studies ranged from two to 18 months. There was consistency across disease areas. For studies of patients with heart failure, the range was two to 18 months. For studies of patients with diabetes, the range was two to 12 months. For studies of patients with COPD, the range was six to 12 months.

c) Study results
In the one cost-utility analysis,[128] a diabetes call station that was managed by non-health care professionals was associated with an incremental cost per quality-adjusted life year (QALY) of £43,300. In another study,[71] there was no difference in costs between telephone management by a nurse manager for patients with heart failure and usual care. In all other studies, the home telehealth strategies were found to lead to reductions in the costs of the health care resources that were included.

d) Study quality
Based on the study quality checklist that was derived from economic evaluations of home telehealth, most of the studies can be considered to be of poor quality (Appendix 11). Seven studies had positive answers to more than half of the 10 items on the checklist. Of these, there were six positive responses for four studies,[23,78,129,130] seven positive responses for two studies,[90,134] and nine positive responses for two studies.[25,128] Even the studies with a high proportion of positive responses had methodological weaknesses.

It is worth examining which study quality items were most adhered to in order to assess whether the key items were addressed (Appendix 11). All studies had a positive response to question 5, which focused on whether the study had compared a strategy of home telehealth with an alternative strategy. This was an inclusion criterion for the review. The questions that came next in terms of the number of positive responses were question 1 (appropriate study question; 20 of 22 studies) and question 3 (RCT or good-quality observational study; 17 of 22 studies). The questions that had the least adherence to good study quality were question 2 (appropriate study perspective; three of 22 studies), question 9 (marginal analysis; four of 22 studies), and question 10 (appropriate sensitivity analysis; three of 22 studies).

e) Review of non-peer-reviewed Canadian reports
Three Canadian reports in the grey literature examined the cost impact of home telehealth. These reports were not peer-reviewed. The reports are described (Appendix 12) in terms of study background, methods, results, and limitations.

5.2 Framework for Economic Evaluations

5.2.1 Background

The framework that is presented in this section for further evaluations of home telehealth programs is consistent with the study quality checklist that was used in the previous section and with the CADTH economic guidelines[137] (Figure 16).

5.2.2 Evaluative framework

a) Focus

An analysis of the economic impact of home telehealth must focus on the incremental costs that are associated with the application of the program to a population of patients and not to an individual patient. This allows for an assessment of the program's impact and includes costs from the patient and population levels. This would also allow the assessments of costs based on different sizes of patient population, as required for marginal analysis.

b) Costs to be included

Telehealth program-specific costs

- Program administration: An evaluation needs to include all costs required to administer the home telehealth program, not just delivery costs.
- Program delivery: The evaluation needs to consider all human resource costs (nursing staff, physicians, and others including IT support) required in the direct care of patients.
- Program capital costs: All the costs of technology that is required for the delivery of home telehealth need to be considered, including those at a system level and those that are used by individual patients. The costs of technology that is used over time must be amortized over the technology's useful life.

Home health care costs

- An evaluation must consider the impact of home telehealth on the volume of nursing and other homecare visits and contacts.

Health care costs

- An evaluation must consider the impact of home telehealth on all pertinent health care resources such as family physician visits, specialist outpatient appointments, emergency department visits, hospitalizations, diagnostic tests and investigations, medications, and specialized equipment (including prostheses).

Patient-borne costs

- Home telehealth can lead to a financial impact on patients and their families and caregivers. The program can increase the burden on families if the aim is to reduce face-to-face contact time with health professionals, as this may require some shifting of responsibilities from the formal health care system to families. Alternatively, home telehealth may be designed to reduce further hospitalizations. This can reduce the costs to patients, their families, and informal caregivers. Given this, the following resources should be considered: travel and other directly borne costs, medication costs, and family caregiver time.

c) Outcomes

Economic evaluation requires an assessment of incremental costs and incremental outcomes of health care programs. Thus, most published studies are not economic evaluations and cannot assist in determining whether a treatment is justifiable based on the impact on costs and treatment outcomes.

Many studies interpret a reduced use of health care resources as evidence of improved outcomes. This may not be the case. Health care resource use may be limited. Because of the way that home telehealth is set up, there may be a reduced frequency of access to other services — not necessarily a reduced need for these services.

Thus, studies should have clinical outcomes (which may be surrogate outcomes such as disease markers) or patient QoL outcomes. If home telehealth is more costly, then studies must take the form of a cost-effectiveness or cost-utility analysis that uses these outcomes.

d) Quality of life

- Evaluations of home telehealth should include a formal assessment of patients' QoL, preferably using established utility questionnaires that would allow assessment of the QALYs gained through intervention. This would allow for an estimation of any short-term effects on utility due to the intervention.

e) Effectiveness

- Clinical outcomes: An evaluation should consider the collection of data on clinical outcomes, such as event rates and deaths that are associated with the disease being studied.
- Surrogate outcomes: In many instances, evaluations of home telehealth programs may have a short time horizon. This will not facilitate the demonstration of differences in long-term clinical outcomes. In these instances, the studies should consider the inclusion of surrogate markers as indicators of no differences in clinical outcomes, for example, HbA1c for diabetes, FEV_1 for COPD, and SBP for heart failure.

5.2.3 Application of framework for economic evaluation

We illustrate the use of the framework for economic evaluations by applying it to the evaluation of a telehomecare demonstrator project, "EMPcare@home,"[20] which was conducted in New Brunswick. Our objective is to highlight how such analyses can be conducted and what additional data would be required. EMPcare@home is a telehomecare initiative for chronic disease management. It is based in the Woodstock Service Unit of the Extra-Mural Program led by the River Valley Health Authority.[20] The Extra-Mural Program provides comprehensive home health care and rehabilitation services to patients in their homes and in their communities.[138] The health care services that are delivered are interventions (including treatment, education, and consultation), service planning, and coordination.[138] The evaluation of the telehealth demonstrator project was used to measure whether the combination of telehomecare, timely staff intervention, and an enhanced patient education program produces a better QoL for patients, is accepted by patients and health professionals, and reduces the need for hospital care.

a) Methods

Study population

Among patients in the study, 70% had CHF or COPD with three or more hospital admissions or had visited the emergency room in the preceding year. In the target population, 30% had other morbidities, such as diabetes or hypertension. Patients with CHF or COPD were the focus of the study.

Patients had to belong to one of these categories:

- A: Patients with CHF or COPD (approximately 70% of total case load)
- B: Patients who needed wound care (approximately 10% of total case load)
- C: Patients who needed palliative care (approximately 10% of total case load)
- D: Patients with other conditions such as diabetes or hypertension or who were receiving anticoagulant therapy (approximately 10% of total case load).

Patient inclusion criteria were:

- Met Extra-Mural Program eligibility criteria
- Had chronic conditions, including but not limited to CHF, COPD, diabetes mellitus, or hypertension, where care coordination could improve resource use and clinical outcomes.
- Needed palliative care because of terminal illness
- Had a wound (surgical, vascular, or pressure) that required care
- Required more than one professional home visit per week because of severity of illness and need for monitoring, management, or education
- If a patient with CHF or COPD, had three or more hospital admissions, or had visited the emergency room in the preceding year, then prioritized for inclusion.

Patient exclusion criteria were:

- Were physically or cognitively unable to learn the process and had no caregiver
- Had a residence that was not conducive to or safe for home monitoring
- Exhibited combative or behavioural problems
- Refused to comply with terms of participation.

Intervention

Patients in the intervention group used a store-and-forward, plain old telephone service-based home monitoring system. The telemonitoring system was used to collect the patient's weight, temperature, blood pressure, pulse, and oxygen levels and was equipped with customizable, pre-recorded messages that included a series of subjective questions that patients could answer to describe their condition.[20] It was designed to accept information from other diagnostic peripherals, such as a blood glucose monitor.[20] Patient vital signs were sent to and stored in a central base station computer at the Extra-Mural Program office in Woodstock for clinical review.

The intervention included a patient education component with existing Extra-Mural Program patient education for CHF and COPD and a cause-and-effect approach as a result of the daily telemonitoring.[20]

Comparator
Patients in the usual care group received standard Extra-Mural Program service delivery from the same staff as the telemonitoring group.

Cost Measurement
In the original evaluation, only volumes of health care resource use was measured. For the application of the framework, an analysis was conducted from the perspective of the Provincial Ministry of Health. Ideally, patient costs would have been included to allow analysis from the societal perspective, but this was not included in the EMPcare@home study.

All costs are presented in 2008 Canadian dollars, with costs from other years adjusted using the Canadian Price Index (Appendix 13a). A one-year time horizon was used for the analysis to facilitate comparison with other studies. Because Extra-Mural Program staff travel time was not reported, only direct costs that were based on the available data were incorporated into the analysis. The cost of each item or service was calculated by multiplying the annualized volume of service by its unit price. Health services utilization and Extra-Mural Program care appear in Appendix 13b and 13c. Variable costs consisted of those for patient-related health care resource and telemonitoring use, and fixed costs were those for non-patient-related health care resource use and those that were associated with telemonitoring; for example, purchase of system and software licences for the health care setting.

The home telehealth technology costs were obtained from the manufacturer, Honeywell HomeMed. Other peripheral costs were obtained from ECRI or from the Health Frontier website. The costs that were associated with health care services use, such as emergency department visits, inpatient care, and Extra-Mural Program staff for a three-month period after patient enrolment (when monitors were in the patients' homes) and for the subsequent three-month period after the monitors were removed (four to six months after patient enrolment) were extracted from the EMPcare@home report.[20] The inpatient length of stay was obtained from the Ontario Case Costing Initiative using ICD10 codes I50.0 (CHF), J44.0 (COPD with acute lower respiratory infection), and J44.1 (COPD with acute exacerbation unspecified) as the most responsible diagnoses during the admission. A weighted average length of stay (LOS) was calculated based on all three diagnoses. Data on outpatient visits and medication use were not reported in the study.

Economic analysis
This model allowed for the conduct of a cost analysis, where clinical outcomes or patient utilities are not measured. The total unadjusted annual direct cost was calculated by group, and the mean total cost per patient was calculated. Ideally, the analysis would have been a full economic evaluation, but the EMPcare@home study did not report QoL or clinical outcomes.

Sensitivity analysis
Two one-way sensitivity analyses were conducted to measure the robustness of the study's results to variations in underlying assumptions. The selection of these analyses was based on assumptions that were related to the average LOS for inpatient care and the unit price of the Sentry monitor. The base-case analysis assumed the unit cost of inpatient care in New Brunswick multiplied by the average LOS. The first sensitivity analysis varied the inpatient costs in

accordance with the minimum and maximum length of hospital stay. In the second sensitivity analysis, a 25% and 50% volume discount pricing were applied as specified in the manufacturer's statement.

b) Results

Appendix 13d reports the unadjusted mean direct costs for the two groups. The telemonitoring group had a total annual cost of $14,678 per patient, while the costs for usual care were $10,161 per patient. In terms of inpatient care and emergency room visits, the telemonitoring group incurred lower costs per patient compared with the usual care group. The Extra-Mural Program staff compensation per patient was higher for the telemonitoring group compared with the usual care group ($320 versus $270). The total direct costs per patient for the telemonitoring group are $11,488 and $2,718 for usual care when the inpatient care for CHF or COPD was used. A large proportion of costs (61%) in the telemonitoring group were due to the cost of the Sentry monitors. In this study, the fixed direct costs account for 1% ($14,315/$1,247,650) of the total direct costs.

c) Sensitivity analysis

Two one-way sensitivity analyses were performed on cost items with the greatest uncertainty (inpatient care LOS and unit price of the Sentry monitor) (Appendix 13e). The minimum and maximum LOS sensitivity analyses had an impact on the total direct cost per patient. When the minimum LOS was applied, the telemonitoring groups had greater costs per patient compared with the usual care groups ($10,091 versus $1,352). On the other hand, the intervention group had a lower cost per patient compared with the usual care group when the maximum LOS was used ($66,160 versus $109,020).

In the sensitivity analysis that was related to volume discount pricing for the Sentry monitor, the total cost per patient was greater in the intervention group compared with the usual care group. The total cost per patient was slightly higher in the intervention group ($10,210 versus $10,161) when a 50% volume discount was applied.

d) Discussion

Our analysis tries to show how the framework for economic evaluations of home telehealth could be implemented. There are limitations to how this can be done, given the absence of data on all health care resources, patient costs, quality of life, and clinical outcomes.

None of the studies that was reviewed adheres to our proposed framework. If future studies adopted this framework, then their relevance to health care decision making would be improved.

6 HOME TELEHEALTH IN CANADA AND ABROAD

6.1 Home Telehealth Technologies Available in Canada

The telehealth devices and accompanying software (Appendix 14) vary in complexity. Some are wireless, stand-alone patient monitoring devices, and some devices provide only medication prompts or reminders. Most of the devices are telephone- or computer-based, with current or

future video and peripherals capability. The peripherals that are associated with home telehealth include devices to measure blood pressure, pulse, respiration, glucose, and body temperature.

6.2 Home Telehealth Programs in Canada

Information on home telehealth programs that are available in jurisdictions that responded to our queries appears in Appendix 15. Six of 10 provinces [British Columbia (Interior Health Authority), Alberta (Northern Lights Health Region), Ontario (University of Ottawa Heart Institute), Québec, New Brunswick, and Prince Edward Island] have established home telehealth programs. Other jurisdictions or regional health authorities, such as the Vancouver Island Health Authority and Northern Health Authority in British Columbia, Saskatchewan, the Ontario Ministry of Health and Long-Term Care, and Nova Scotia have pilot projects in progress. Manitoba, Newfoundland and Labrador, the Northwest Territories, Nunavut, and Yukon do not have home telehealth programs, but may be planning one, or they may have a call centre.

Most home telehealth programs in Canada target populations with chronic diseases, such as diabetes, COPD, asthma, depression, and cardiovascular diseases, or palliative care. The Interior Health Authority in British Columbia has a pilot project underway for patients with wounds.

6.3 Chronic Diseases Managed through Home Telehealth

In addition to the three chronic diseases (diabetes, heart failure, and COPD) that are covered in this review, home telehealth has been used to manage other chronic diseases (Table 7). The studies were published in Canada and internationally.

7 HEALTH SERVICES IMPACT

7.1 Introduction

Every technology comes with ethical and legal issues that surround its application. Each application is uniquely situated in the social matrix (the social-legal and ethical framework in which patients and professionals are embedded). It cannot be assumed that the solutions developed for the original context are workable or acceptable when transferred to another setting. Therefore, it is appropriate that the transfer of electronic telemetry, data gathering, and communication technologies and techniques from the domain of industry, where they were originally developed, into the domain of health care — and specifically to the home telehealth management of COPD, heart failure, and diabetes — be preceded by a consideration of the ethical and legal issues that this may raise.[230]

Providing these considerations can be approached topically, by arranging the analysis and discussion according to types of issues; procedurally, by unfolding the issues sequentially as they arise in the process of transfer and application; or subjectively, from the perspective of relevant stakeholders. It is irrelevant which approach is adopted as long as all issues are identified, placed into proper context, and their implications examined. Approaching the matter topically facilitates the identification of the multiple implications of telehealth and is likely to lead to a clearer

appreciation of the ethical considerations that affect the stakeholders. This is the approach that has been adopted.

Table 7: Chronic Diseases Managed through Home Telehealth

Chronic Diseases	Country	References
CVD	Canada, US, Italy, Turkey	A,[139-142] C,[143] D[144]
Hypertension	US, Canada, France, Denmark, Germany, Poland, Japan, Estonia, Hungary, Italy	A,[145-156] B,[157-161] C,[162-164] D[165-167]
Asthma	UK, US, The Netherlands, Taiwan, Greece, Croatia	A,[168-174] B,[175,176] C,[177-180] D[181]
Renal failure (hemodialysis, peritoneal dialysis)	Japan, Spain, The Netherlands, Australia	A,[182] B,[183,184] C,[185,186] D[187]
Chronic wound care	Switzerland, US, Poland, Denmark, Austria	A,[188,189] B,[190-195] D[196-199]
HIV/AIDS	Spain, US	B,[200] C,[201] D[202]
Mental health		
• Bulimia nervosa	Sweden	A[203]
• Dementia	Korea, Japan, US, Sweden, Taiwan, UK	A,[204] C,[205-207] D[208,209]
• Alzheimer disease	US	A[210]
• Depression	US	A,[211] B,[212]
• Schizophrenia	UK	A[213]
Inflammatory bowel disease	US	B,[214-216]
Pediatric oncology	Australia	A[217]
Sleep disorders	US	A,[218,219] B,[220] D[221]
Cancer	US	A[222]
Cystic fibrosis	Australia	B[223]
Chronic brain injury	Italy	B[224]
Chronic migraine	The Netherlands	B[225]
Chronic pain	Canada	B[226]
Arthritis	US, UK	A,[227] B[228]
Obesity	US	A[229]

A=comparative studies; B=feasibility or case studies; C=study or description of the technologies; CVD= cardiovascular diseases including stroke, myocardial infarction, and coronary artery bypass; D=reviews including systematic reviews.

7.2 Patient and Health Human Resource Implications

7.2.1 Home telehealth and patients

Home telehealth is the application of data gathering, communication, storage, and manipulation technologies and techniques to health care delivery in the patient's home. As a species of health care, home telehealth must satisfy the same ethical principles that govern the delivery of health care. These principles include autonomy, equality, beneficence, non-malfeasance, and integrity.[231-233]

a) Consent

In practical terms, as is the case with any other health care modality, patient participation in home telehealth must be on the basis of competent, informed, and voluntary consent.[234-236] This is all the more important if indwelling monitors are involved, as their use constitutes an

infringement of the integrity of the person. Consequently, under Canadian law and in keeping with good ethics, enrolment must be voluntary, and protocols must ensure that prospective participants are told, before enrolment, what an objective reasonable person in their position would want to know about all relevant aspects of home telehealth. It means that, at a minimum, prospective participants must be informed about monitoring and communication features, the nature of response modalities in the event of emergencies, the use and disposition of identifiable data, the role of the professionals who are involved, and the implications of their acceptance or refusal of this health care modality. Disclosure of this information must be geared to the patient's level of understanding.[237] Patients must be told that they may withdraw from participation without losing their right to otherwise usually available care or in the event that such care may no longer be available, why (and to what degree) that would be the case. The consent process must acknowledge any advance directives from patients or substitute decision makers who have been identified. These directives and decision makers must be integrated into the health care plan as it has been restructured to involve home telehealth.[237]

b) Human factors

The human factors that are involved in standard health care must not be lost by the introduction of this technology.[238] The protocols must be sensitive to cultural and individual variations among patients. This means that prospective participants must be told that while there is evidence that enrolment may foster a feeling of freedom and empowerment,[239] because patients become active participants in their own care,[240] and while home telehealth may encourage a feeling of security and continuity of care, because of the immediate availability of professional contact and help in case of need or adverse events,[239] there is evidence to show that it may foster a feeling of isolation, because the technology may be experienced as a substitute for direct personal interaction with health care professionals.[235,241] Some patients may form unreasonable expectations about efficacy and outcomes, because of the monitoring and the ease and immediacy with which health care professionals may be contacted.[231] The consent process must be accompanied by education that clarifies these issues and that is geared to the individual patient.[240] Education and care plans must be appropriately reviewed and adjusted through relevant professional-patient interaction.

c) Home environment

Because home telehealth involves the installation and use of technology, it will have an element of obtrusiveness.[242-244] It may have the effect of medicalizing the home.[235,245] The use of in-home intravenous antibiotic treatment, oxygen therapy, or peritoneal dialysis has a similar effect. Home telehealth is different, however, because, in the case of installed telemetry and of automated surveillance and indwelling devices, it will involve the continuous virtual presence of caregivers. Therefore, it may foster a "Big-Brother-Is-Watching" feeling in some patients.[242,246] This possibility must be acknowledged and guarded against, because it would be contrary to the therapeutic nature of health care as traditionally practised. Likewise, the installation and use of the technology may have a negative effect on patients' interaction with their significant others as caregivers and on a human level.[247] Consent processes and protocols must be sensitive to these factors, and appropriate counselling must be provided.[248]

d) Selection

The offer of and access to home telehealth must not be based on patient resources beyond what is standard in other methods of health care delivery, as this would violate the principle of equality.

The selection should not offend section 15 of the *Charter of Rights and Freedoms,* which prohibits discrimination with respect to services that are offered by public agencies. Care should be taken to ensure that the selection process does not offend relevant provincial or territorial human rights legislation. As in all other cases, selection must be based solely on medical criteria and on the probability that the patient will benefit from the use of such technology.[234,249,250] It may be, however, that age, disability, and culture-related factors may play a role in this regard without offending equality and justice. Mental disability in particular and cultural values that centre in privacy or in the preservation of body integrity may be implicated.

e) Liability

Home telehealth turns patients (and their significant others) into active co-participants in the delivery of health care.[240,251,252] Another issue that should be settled in advance is that of liability in case of patient mistake or error. For instance, how should responsibility be assessed if patients make mistakes in taking readings or misreport their values or if they accidentally interfere in automated measurements or their transmission and interventions are based on the data that are provided? The issue of co-responsibility for significant others who assist the patient in the execution of relevant protocols deserves consideration. Current models of the health care professional-patient relationship, which focus on direct patient-professional interaction, may be incompletely applicable to this type of situation. Some means should be developed to apportion liability in cases where medical misadventure occurs as a result of mistakes made conjointly by patients and professionals. Ideally, delivery protocols and the informed consent processes should be structured to acknowledge this. The delivery of home intravenous antibiotic treatment and oxygen therapy may provide useful models in this regard.

f) Training

Home telehealth involves means, protocols, and devices that are not obvious to the average patient. These require appropriate and adequate training to meet the ethics of care. The education process should also be tailored to the individual patient and to the significant others who may become involved in the deployment and use of the technology.[240] The protocols should be implemented so that the uptake of relevant information is monitored and patients and involved parties are updated regularly according to the demands of the situation.

g) Privacy and confidentiality

Home telehealth relies on the collection, communication, storage, use, and manipulation of patient data. Such activities are subject to the provisions of the federal *Personal Information Protection and Electronic Documents Act*[253] and of corresponding provincial legislation. These form the background against which home telehealth should be implemented. The *Privacy Impact Assessment Policy*[254] and *Privacy Impact Assessment Guidelines,*[255] which are promulgated by the Secretariat of the Treasury Board of Canada, may provide assistance from a process perspective. More guidance may be found in the Canadian Medical Association's (CMA) *Health Information Privacy Code*[256] and the *Guidelines for the Protection of Health Information*[257] of the Canadian Organization for Advancement of Computers in Health (COACH). The ethical basis for the CMA's position may be found in the World Medical Association's *Statement on Accountability, Responsibilities and Ethical Guidelines in the Practice of Telemedicine,*[258] *Statement on the Use of Computer in Medicine*,[259] and *Declaration on Ethical Considerations Regarding Health Databases*,[260] and the ethical basis for the COACH *Guidelines* may be found

in its statement of *Ethical Principles* [261] and in the *Code of Ethics for Health Information Professionals*[262] of the International Medical Informatics Association.
Because legislative provisions tend to lag behind ethical developments, these may be consulted to avoid future difficulties. As a rule, all collection, communication, storage, use, and manipulation of patient data is subject to the same rules and structures.[261,263-265] Thus, all persons who are involved in the deployment and delivery of home telehealth will be bound by the same obligation of patient confidentiality that characterizes other modes of health care delivery.[231,235,266-268]

Except for approved research projects by accredited researchers conducted in accordance with federal and provincial legislation or for bona fide administrative functions conducted by authorized agents, identified (or identifiable) patient data may be accessed only with informed consent. Moreover, patients retain the same right to usual care the use of identified data for research purposes as currently obtains for all other modes of health care delivery.[269]

Finally, patients must be secure in the assumption that data transmission is secure[270] and that accuracy will be unaffected by the modes of collection or transmission. Another factor that deserves consideration is the development and use of unique patient identifiers.

7.2.2 Home telehealth and health human resources

a) Fiduciary nature of health care professional-patient relationship

The health care professional-patient relationship is fiduciary.[236,265,271-274] Its hallmarks are good faith, loyalty, and trust. There is evidence that home telehealth improves outcomes.[239,275] Therefore, home telehealth should be considered as a treatment option by physicians who are concerned with fulfilling their fiduciary obligation. This is relevant for populations who reside in remote areas where access to appropriate care is compromised and where the provision of home telehealth would fill an unmet need. The introduction of home telehealth should not be disruptive of the overall treatment plan that otherwise exists or result in a lower level or quality of care that would otherwise be available. It is worthwhile to consider whether care from response personnel in call-in centres, or from those monitoring patient data, whose qualifications are not equivalent to those from whom the patients otherwise would receive care — for example, physicians — constitutes a breach of fiduciary obligation. The outsourcing of professional services to different jurisdictions has been mentioned in the literature.[276] In the absence of uniform standards and inter-jurisdictional certification, this option may present ethical and legal problems.[277]

b) Immediacy versus abandonment

Patients may dismiss their caregivers at any time. Health care professionals, however, must take care not to abandon patients.[278] The literature suggests that the use of home telehealth may be viewed ambivalently in this respect. While in some cases patients have reported an increased sense of care and involvement,[279] in others they have reported a feeling of distance[280] and an impression of abandonment.[281] Moreover, the perceived shift from a person-centred to a technology-focused relationship may ambivalently affect autonomy and respect as perceived by the patient.[239,282] Therefore, home telehealth care plans should be tailored to the needs of the individual patient and not be based only on financial considerations, lest the fiduciary nature of the professional-patient relationship be compromised.[278]

c) Home telehealth and codes of ethics

Is the professional guidance that is provided by current codes of ethics sufficient and appropriate for e-Health?[236] Two CMA policy statements — *Physician Guidelines for Online Communication with Patients*[263] and *Guiding Principles for Physician Electronic Medical Records (EMR) Adoption in Ambulatory Clinical Practice*[264] — try to update guidance on traditional obligations. They are incomplete, however, and do not cover all aspects of home telehealth. Additional guidance had been provided by the World Medical Association's *Statement on Home Medical Monitoring, "Tele-Medicine" and Medical Ethics*. This *Statement* was rescinded in 2006.[283] Other attempts have been made to draft codes and practice guidelines.[284] None of them, however, applies directly to the Canadian socio-juridical setting. Therefore, the incompleteness of current professional codes and standards should be acknowledged in the deployment of home telehealth and steps should be taken to ameliorate the situation with ethical and legal education and training.[285]

d) Training, liability, and malpractice

Because home telehealth is a new method of health care delivery, it is not an integral and established part of the education and training of health care professionals. This suggests that targeted professional education and training should precede the deployment of home telehealth and that continuing education programs that are similar to those that are found in other areas of health care should be developed. It may be useful to explore whether, given that it is a non-standard method of care, professional licensure, standards, and certification require special attention.[286] Health professionals will require classroom training and hands-on experience with the equipment to ensure the success of the new technology.[287]

Because home telehealth integrates patients and significant others into the health care process as co-providers in a way that differs from other modes of delivery — particularly when data-collection, monitoring, and transmission are not automated[268] — this raises questions about professional liability and malpractice. Concerns have been expressed, and it has been asked whether current models of liability and malpractice can simply be transferred to this setting.[286,288,289] The training of professionals for emergency situations is noteworthy, as is the use of algorithms by non-medical personnel instead of the use of a physician's judgment to identify and deal with adverse events.[143]

e) Reimbursement

In Canada, the reimbursement of health care professionals for publicly provided services is governed by rules and tariffs that are set by provincial authorities. It may be useful to determine before implementation in what way and to what extent home telehealth services are covered by the existing provisions, lest current billing practices have to be extended beyond their strict limits, because this may cause ethical and legal difficulties.[267,275,290-293] Similar remarks apply to reimbursement for originating facilities, as has been illustrated by the US experience under Medicare and Medicaid. [The Center for Telemedicine Law. *Telemedicine Reimbursement Report,* available at ftp://ftp.hrsa.gov/telehealth/licen.pdf]

f) Institutional considerations

With due alteration of detail, the preceding considerations also apply to all institutional health care providers who are involved in the delivery of home telehealth. Institutional considerations also involve factors that are a result of the technology itself.

g) Traits and skills of home telehealth providers

The success of home telehealth relies on the competency of the home telehealth providers. Home telehealth providers must have expert assessment skills and must communicate effectively while engaging in equipment-related tasks.[294-296] One study[295] suggested that basic computer skills were paramount, and home telehealth providers required skills in how to operate cameras. Other authors[295,297,298] recommended skills in electronic documentation.

Some of the home telehealth providers' job responsibilities are different compared with the job responsibilities of traditional home care visits. For example, they may be required to learn how to install, calibrate, and operate the technology and to recognize and solve technical problems.[299] One study outlined the nurses' perception of differences between traditional nursing and telenursing (Table 8).[297,298]

Table 8: Nurses' Perception of Differences between Traditional Nursing and Telenursing[297,298]

Traditional Nursing	Telenursing
Hands-on treatment and assessment of patients	Lack of hands-on treatment and assessment
Fewer patient education opportunities	More patient education opportunities
Little reliance on patient co-operation	Increased reliance on patient co-operation
Little patient responsibility for care	More patient responsibility for care
Wide range of patient types and diagnoses	Decreased patient types and diagnoses
Wide range of patient observation	Decreased range of patient observation

According to an evaluation of a home telehealth demonstrator project for chronic diseases in New Brunswick, the health care providers found the telehealth technology helpful in their jobs in terms of daily monitoring, patient education, and decreased in-person visits.[20] Health care providers in one pilot study in eastern Ontario found the home telehealth units useful for monitoring long-term trends and collecting clinical data from the patient.[300] They noted that there could be improvement in areas related to technical problems or customer support and staff training and that other improvements could include the ability to create new questions other than those included in the software and a shortened educational tool.[20] A concern was raised by a cohort of nurses (n=12) who viewed the technology as undermining the nurses' professional security and credibility.[301]

h) Integration of home telehealth into existing health care systems

Home telehealth technologies will likely result in changes in the health care system and introduce new possibilities for health services delivery and integrated care.[302] The effects of introducing home telehealth into the health care system remain unclear, because many studies evaluate the clinical outcomes and not the systematic impacts.[303] The transition period may be long because of the training of staff and changes to the system infrastructure, so the benefits of home telehealth may be realized only several years after its implementation.[303] It is paramount to objectives for the integration of home telehealth into the existing health care system.[304] An understanding of how well the traditional home care services are achieving their objectives must be developed.[11] Moreover, the existing health services delivery model and how home telehealth can enhance it and improve the use of scarce resources must be examined.[304,305] A gradual shift to a home telehealth-supported delivery model may be more realistic.[303]

Before implementation of home telehealth technologies, several questions must be considered:[11]

- Disease burden of chronic illness: Which conditions have the highest resource use?
- Changing patterns of health care resource use: What types of resources are available and required?
- Home care indicators: Data from six areas are regularly required: health conditions, human function, personal resources, accessibility, effectiveness, and health system characteristics.
- Home telehealth evidence: What are the most effective home telehealth technologies to support provision of these services?
- Implementation of change in practice: Does the evidence support using the technology to achieve desired patient outcomes or reduce service delivery costs.
- Context: What factors contribute to the complexity of implementation?

Stakeholders in the implementation process need an understanding of telehealth solutions and appropriate applications and should realize that the benefits for health care systems may take time to materialize.[303]

7.3 Risk Management and Legal Issues

7.3.1 Appropriateness, safety, and reliability

Home telehealth can be effected by using available software, devices, and algorithms that differ in invasiveness, obtrusiveness, safety, reliability, and security. Not all are equally compatible with a treatment plan or are equally acceptable to a patient. Fidelity entails that the chosen technology should fit the treatment plan that would otherwise be appropriate for and be acceptable to the individual patient, rather than having effectiveness, ease of implementation, or expense being the drivers for the modality that is offered.

Moreover, home telehealth may involve distinct material items and protocols. Interoperability and appropriateness are necessary conditions. Otherwise, treatment may be impaired by the technology and the fiduciary obligation of attendant health care professionals put at risk.[282]

The literature has identified device safety[306-309] and the standardization of technologies and protocols as issues, because these may affect the quality of care.[275,310] The technology's ability to ensure data integrity is an issue.[307] Functional reliability and the power to accurately gather and communicate the relevant data with appropriate back-up measures to guard against malfunction or interruption have been considered.[311] In each case, there are ethical and legal implications regarding product and service liability.

a) Confidentiality and security

Confidentiality and security have been identified as central issues. From a technological perspective, this means that all measures, devices, and techniques inclusive of those used for communication and storage should satisfy or exceed otherwise applicable confidentiality and security requirements.[312-315] Logs and processing technology should meet similar standards. They should include tracking, authentication, and non-repudiation measures to minimize the chance of inappropriate access and allow for the monitoring of appropriate usage.[316,317] In the case of non-dedicated communication lines, robust encryption has been suggested to preserve security and

privacy.[307,316] Some authors have suggested that the technical infrastructure should include passwords and public key encryption with a trusted third-party as the intermediary.[318]

Data storage should be technologically secure from unauthorized intrusion, use, access, destruction, loss, and modification.[316,319] User authentication measures are considered to be important,[317,320,321] and protocols should be in place to migrate records without loss of integrity in case this becomes necessary. There should be provisions to ensure that software is appropriately updated so that records can continue to be read, accessed, or handled despite technological changes. In all these contexts, manufacturer liability may be an ancillary concern.

b) Patient identifiers

Electronic patient records are integral to home telehealth.[275] Such records require the use of identifiers to appropriately link data to individual patients for the delivery of care and to enhance privacy by facilitating data severance (when the identifiers are stripped from the data so that the data are dissociated from the identifying material). The use of unique identifiers has been discussed,[322-325] and options ranging from numerical through alphanumerical to biometric measures have been considered. There is no national patient identifier in Canada, and different health care providers use different approaches. If home telehealth is to be implemented, it may become necessary to develop a consistent identifier format that is consistent with applicable privacy legislation while being transferable on a national basis. Otherwise the spirit if not the letter of the *Canada Health Act*, particularly in regards to its universality and accessibility provisions, may be violated. It may be appropriate to consider the recommendations of the *Romanow Report* which, *inter alia*, suggests the establishment of individual electronic patient records for all Canadians — something that cannot be done without unique patient identifiers[7] — and the recommendations of the Canadian Institute for Health Information, which expands on the need for unique patient identifiers as a technical requirement for setting up electronic patient records and implementing electronically assisted health services.[322]

7.4 Ethical, Equity, and Psychosocial Issues

7.4.1 Canada Health Act and its implications for telehealth

Health care in Canada is a matter of provincial jurisdiction.[326] The *Canada Health Act* (CHA) cannot dictate how health care delivery is to be structured by the provinces. Nevertheless the CHA identifies, from a policy perspective, fundamental values that the provinces must meet to qualify for federal transfer payments. Comprehensiveness, universality, and accessibility are particularly relevant to the present context. They are grounded in the ethical principle of equality and justice.

If home telehealth presents a cost-saving over traditional modes of delivery, it would support the philosophical perspective that underlies the criterion of comprehensiveness. It would free up provincial funds to allow an extension of the range of provincially insured health services. For similar reasons, it would make it easier for provincial providers to meet the condition of universality. If successful, home telehealth would advance the value of accessibility as stated in the CHA.

Nevertheless, if home telehealth is to fall in the ethical framework of the CHA, the economic measures used to validate it must be compatible with equality and justice. This may require a closer look at QALYs and DALYs, both of which are not undisputed in terms of the ethical foundation.[327-330] It also means that the financial capacity of prospective users to defray ancillary costs must not be a barrier to equitable access.

A society that believes in equality and justice will treat health care as a right, not as a commodity. This is the perspective that underlies the CHA and that is embraced by Canadians.[7] Moreover, the health care professional-patient relationship is fiduciary — a fact that is unaffected by the way this relationship is initiated and effected. Each person is surrounded by a sphere of privacy which, except for the most important of purposes, lies in the care of the individual. These factors determine the ethical and legal development and deployment of home telehealth. Therefore, while privacy and security are concerns that home telehealth must meet, these are necessary but not sufficient conditions. The ultimate determinant is whether home telehealth will deliver, as a minimum, the same quality of care that patients would otherwise receive. If that is not the case, then it may run afoul of the Supreme Court's requirement in *Eldridge v. British Columbia*, in which patients are entitled to expect that public health care providers will provide them with "equal benefit ... without discrimination" as in section 15(1) of the Charter of Rights and Freedoms.[331]

7.5 Budget Impact Analysis

Given that this report does not involve a formal assessment of a particular home telehealth intervention, a budget impact analysis is inappropriate. The three disease areas that are considered in this report are associated with a high burden of disease (EBIC 1998).[332] To calculate the impact on the economic burden of disease (and hence the budget impact) of a home telehealth program, it would be necessary to conduct an assessment of the costs of the home telehealth intervention and its effect on the use of other health care resources. Although, most of the economic studies reviewed in this report suggested that home telehealth may lead to an overall reduction in health care costs, the studies were of poor quality. Thus, it is not possible to determine the budget impact of further investment in home telehealth in Canada.

8 DISCUSSION

8.1 Summary of Results

Seventy-eight studies that are related to home telehealth for diabetes, heart failure, COPD, and mixed chronic diseases were included in our clinical review. The quality of the studies ranged from very high (18 RCTs) to very low (three observational studies). The clinical-effectiveness and impact on health services utilization of home telehealth were presented. Overall, home telehealth interventions (home telemonitoring and telephone support) are effective for improving glycemic control for patients with diabetes and for reducing mortality rates among patients with heart failure using a home telehealth intervention. The study results showed a higher mortality rate among patients with COPD using home telehealth interventions, but the number of original

studies was few, and sample sizes were relatively small. Hence, the outcomes must be interpreted cautiously.

Health services utilization outcomes suggest that home telelealth interventions help to reduce the number of patients who are rehospitalized, number of hospitalizations, number of emergency department visits, and BDOC. The number of primary care, specialist, office, and home care visits were higher among patients using home telehealth interventions in some studies. Patients who were using home telemonitoring or telephone support may have been more active in their disease management. Therefore, they are more closely followed by physicians or nurses compared with patients receiving usual care. In several instances, the number of studies was very few (n=1), so the external validity may be questionable.

Most systematic reviews suggest that home telehealth is an effective intervention for chronic disease management; but some reviews, even those published in 2007, found the evidence to be limited.

The QoL and patient satisfaction outcomes were qualitatively reviewed for diabetes, heart failure, COPD, and mixed chronic diseases. QoL or patient satisfaction were measured with various instruments, but the study results indicate that home telehealth interventions were similar or favourable to usual care in terms of QoL, patient satisfaction, adherence to treatment, or compliance.

Clinical heterogeneity was present because of a diverse patient population (patients with multiple chronic diseases), study design (for example, RCTs and observational studies), and length of follow-up and interventions (home telemonitoring and telephone support) in our review. Other potential sources of heterogeneity were differences in patient selection related to age, disease severity (for example, NYHA for heart failure) and classification (for example, type 1, type 2, or gestational diabetes) and variations in intervention (for example, telephone, home monitors, videoconferencing, Internet). Given this limitation, decisions on the appropriateness of a meta-analysis are based on judgment by the reviewers.[333] Where substantial statistical heterogeneity existed (I^2>50%), the reviewers (KT and JP) decided to review the outcomes qualitatively to reduce the risk of presenting spurious summary estimates.

Most studies in our economic review found home telehealth to be cost saving from a health care system perspective. This was consistent by disease area and by the home telehealth intervention. The quality of these studies, however, in terms of economic evaluations is very poor, which puts into question the validity of the study results. In addition, the studies are highly heterogeneous possibly because of diverse study populations, the interventions used, and the health care systems in which they are based, so it remains a challenge to make an informed decision on resource allocation. A framework for economic evaluation advocates that an assessment of a home telehealth program includes costs at the patient and population levels to facilitate the comparison for different size populations.

Our environmental scan of home telehealth programs across Canada is an indicator of the opportunities to improve accessibility to the health care system for patients with reduced mobility or living in remote locations. Based on responses to our survey, programs in operation

or under development cover various patient populations, such as those with diabetes, COPD, asthma, cardiovascular diseases, or wound care management. Patients in jurisdictions without a home telehealth program may receive health care services through the local telehealth network or nurse call centre.

The ethical, legal, and psychosocial section highlighted issues in home telehealth related to patient-centred issues, professionally grounded issues, technology-based issues, and issues derived from social expectations outlined in the CHA. Patient-centred issues include privacy and confidentiality, informed consent, patient selection, and the psychosocial implications of technology as a result of medicalization of the home environment. Professionally grounded issues centre on liability and malpractice, because patients become active co-participants in health care delivery with home telehealth, and employee training becomes more critical because home telehealth is not a mainstream method of health care delivery. Technology-based issues focus on reliability, privacy, and safety. One ethical and legal concern that affects the field of e-health, not just home telemonitoring or telephone support, is the lack of a national unique patient identifier in Canada. A standard identifier format that conforms to applicable privacy legislature and that is transferable at the national level to meet the universality and accessibility principles of the CHA is essential.

8.2 Strengths and Weaknesses of this Assessment

This report assessed the quality of clinical and economic studies for chronic disease management, with a focus on diabetes, heart failure, and COPD. A framework for economic evaluations and a cost-analysis using available Canadian data were presented to guide future research. Other components of this report include the Canadian perspective of home telehealth (available home telehealth technologies and home telehealth programs in Canada) and a discussion of ethical, legal, and psychosocial issues related to home telehealth as one approach to health care delivery.

There are limitations to our research. Comparisons of real-time versus asynchronous technologies were not part of the primary objectives and were not explored in detail. The pooling of outcomes in our meta-analysis resulted in high statistical heterogeneity between studies (I^2>50). Several subgroup analyses by study design (RCTs and observational studies versus RCTs alone) or home telehealth intervention (home telemonitoring versus telephone support) were conducted to explore heterogeneity. Statistical heterogeneity, however, remained unexplained in some cases. Given the limited number of studies in the subgroup analyses, a meta-regression was not carried out. As a result, clinical and health services outcomes in many studies were reviewed qualitatively. A qualitative economic review was also conducted, because of differences in the patient populations, study designs, and interventions.

There is an insufficient number of studies in the subgroup analyses to measure the potential of publication bias related to clinical and health services utilization outcomes. Nonetheless, the literature search was comprehensive, and it included published and grey literature, reducing the risk of report bias for outcomes.

8.3 Generalizability of Findings

The studies in the clinical review focused on diabetes, heart failure, and COPD. Several studies that evaluated home telehealth for mixed chronic diseases, including mental health, were also reviewed, and their findings are consistent with those of the other studies in our report. The number of studies and sample sizes were low for the number of outcomes measured. Patients with cognitive impairment, mental illness, a language barrier, no telephone line or computer to transmit data, or a life expectancy of less than one year were excluded from most diabetes, heart failure, and COPD studies, so the generalizibility of findings may be limited.

The economic studies that were reviewed found health care interventions for chronic disease management to be cost-saving from a health care system perspective, though they are generally of poor quality. The primary economic analysis compared the annual cost per patient between home telemonitoring with usual care, but the exclusion of clinical or health services utilization or QoL outcomes, because of a lack of available data, prohibited the authors from accurately measuring the potential cost-savings of home telehealth.

8.4 Knowledge Gaps

There is variability in the quality of studies in this review because of methodological limitations in the study designs or small sample sizes. More studies of higher methodological quality (for example, multicentre RCTs) are required to give more precise insights into the potential clinical-effectiveness of home telehealth interventions. Studies should include more diverse patient populations with diabetes, heart failure, and COPD to increase the external validity of their outcomes.

As discussed in the framework for economic evaluations, future research should measure the economic impact of home telehealth programs as an entity for a patient population and not just at the population level. While health services utilization outcomes are necessary to measure resource use, studies should incorporate at least one clinical outcome (disease marker) or patient QoL in the analysis. It can then be determined whether lower health care resource use can be attributed to reduced access to health services or a reduced need for these services. In addition, research to help identify those patients who can benefit most from home telehealth interventions is needed, and a standardized approach to the evaluation of home telehealth initiatives should be developed to help increase the quality of studies and amount of evidence available.

9 CONCLUSIONS

Home care is an instrumental part of the chronic disease management model, and home telehealth is an extension of health care delivery in a patient's home. Our clinical review showed that home telehealth is generally clinically effective, and no patient adverse events were reported in the included studies. Evidence on the impact of health services utilization is more limited but shows potential in some studies. Our economic review reported home telehealth to be cost-saving, although the overall quality of the original research was low.

It is evident from the responses to our pan-Canadian survey of home telehealth programs that home telehealth interventions are becoming an integral part of health care delivery to improve access to health services. The survey also showed that there exists a viable industry that can support implementation of home telehealth. More research, such as multicentre RCTs, is warranted to accurately measure the clinical and economic impact of home telehealth for chronic disease management to support Canadian policy makers in making informed decisions.

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351. Department of Health and Social Services. *Health and Social services [Internet]*. Iqaluit: Government of Nunavut; 2008. Available: http://www.gov.nu.ca/health/ (accessed 2008 May 23).

FIGURES

Figure 1: Flow chart for clinical considerations

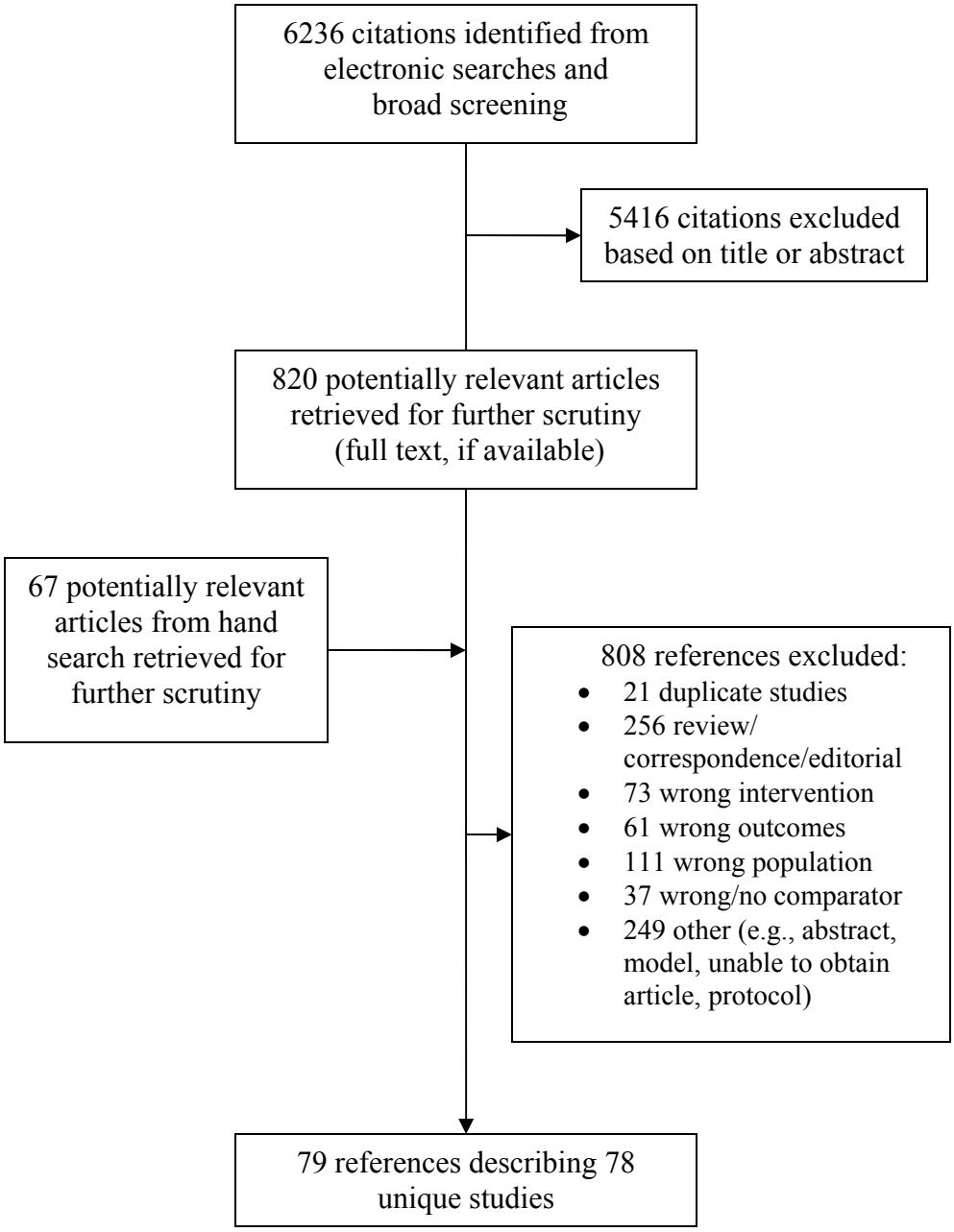


Figure 2: Flow Chart for Ethical and Legal Considerations

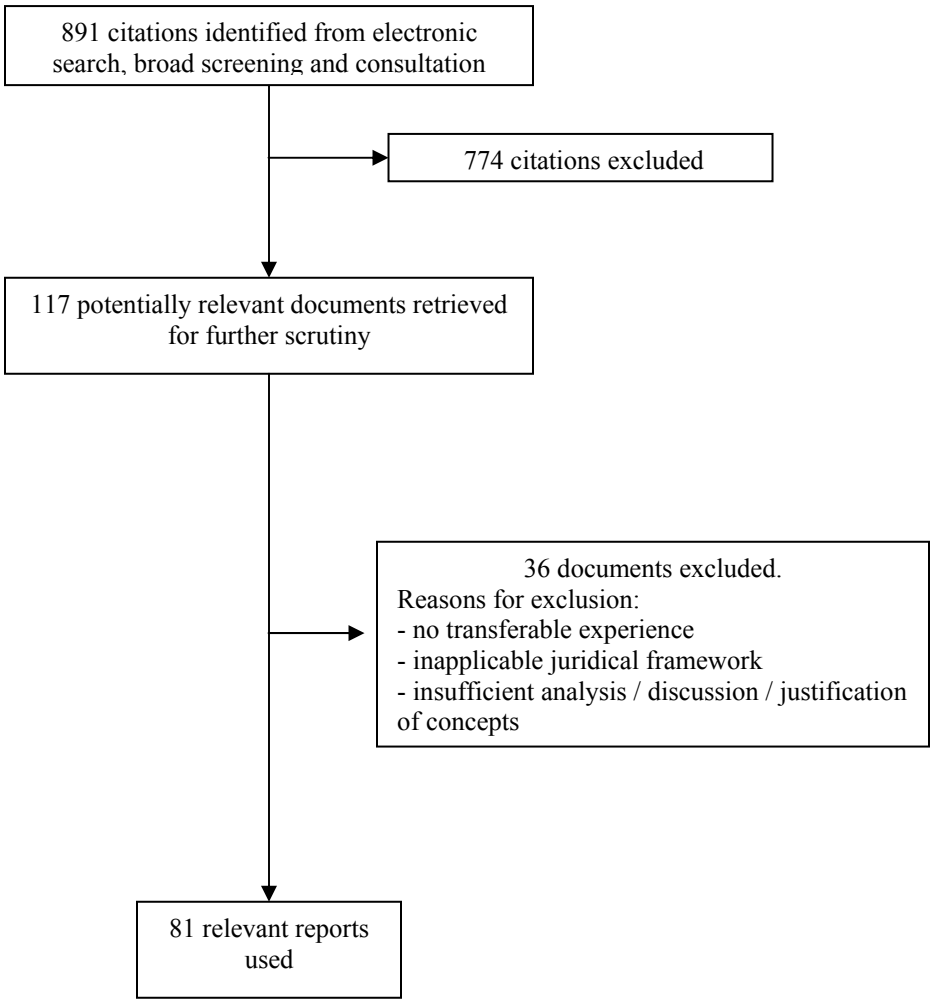


Figure 3: Mean difference of HbA1c between home telemonitoring and usual care

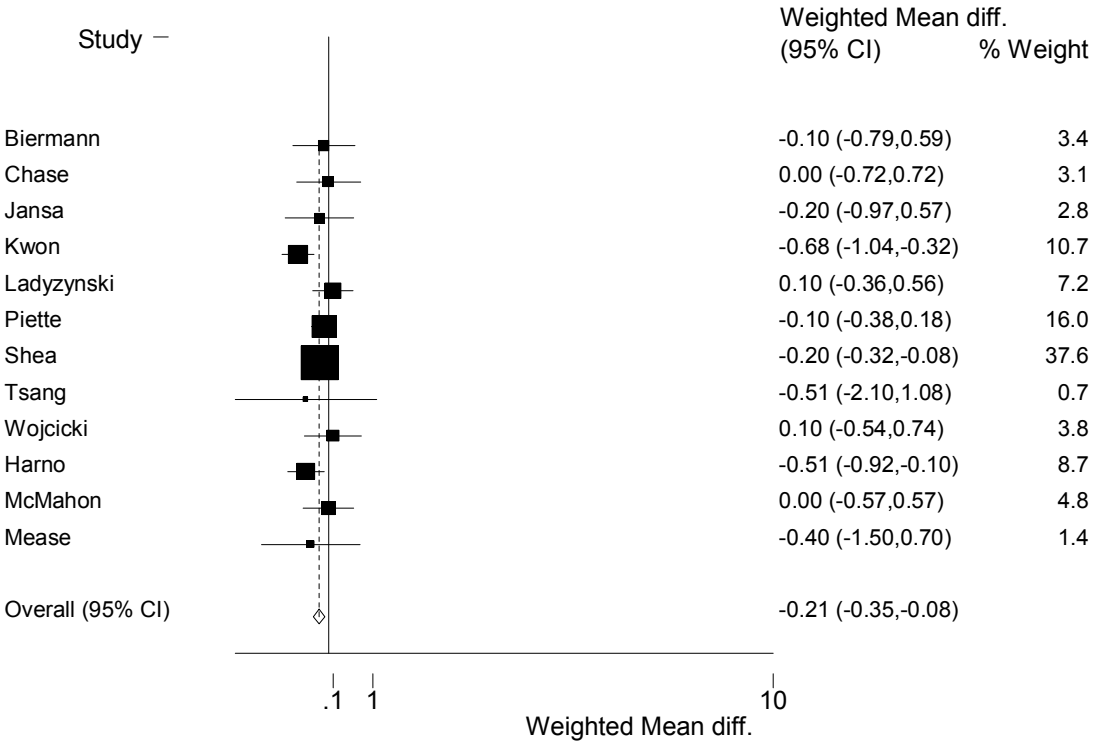


Figure 4: Relative risk of number of HF patients rehospitalized (all-cause) between HTM and UC

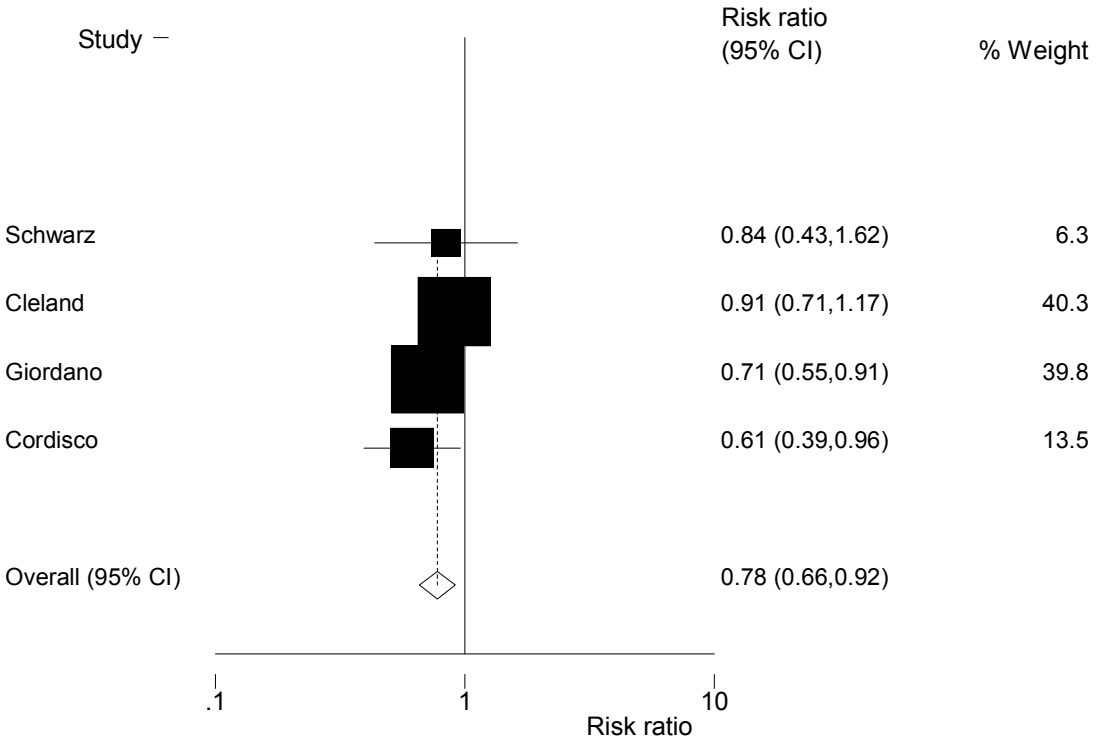


Figure 5: Relative risk of HF patients re-hospitalized (all-cause) between TS and UC

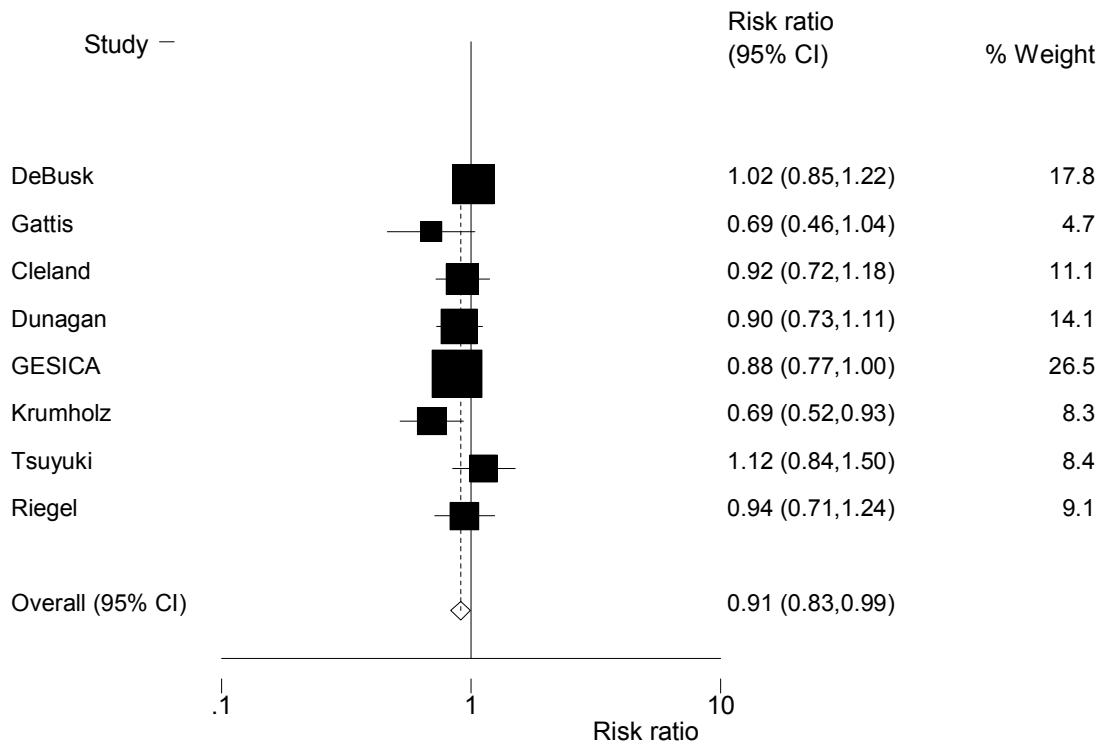


Figure 6: Relative risk of HF patients re-hospitalized (HF-related) between TS and UC

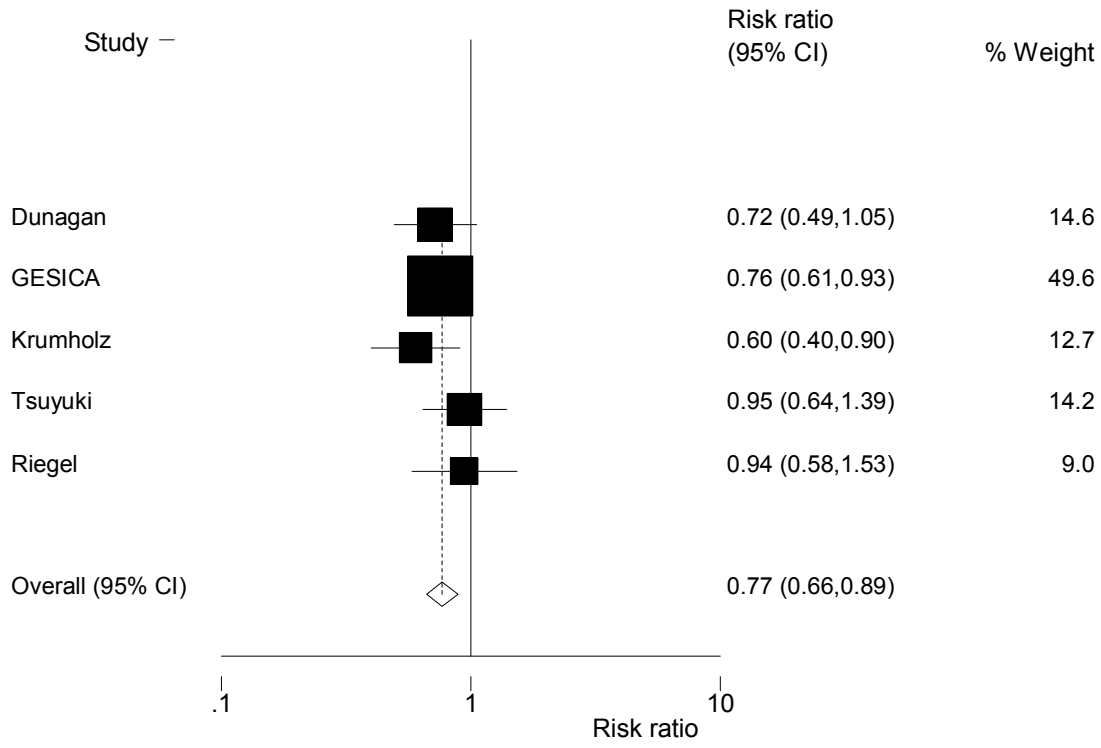


Figure 7: Relative risk of all-cause deaths of HF patients between HTM and UC

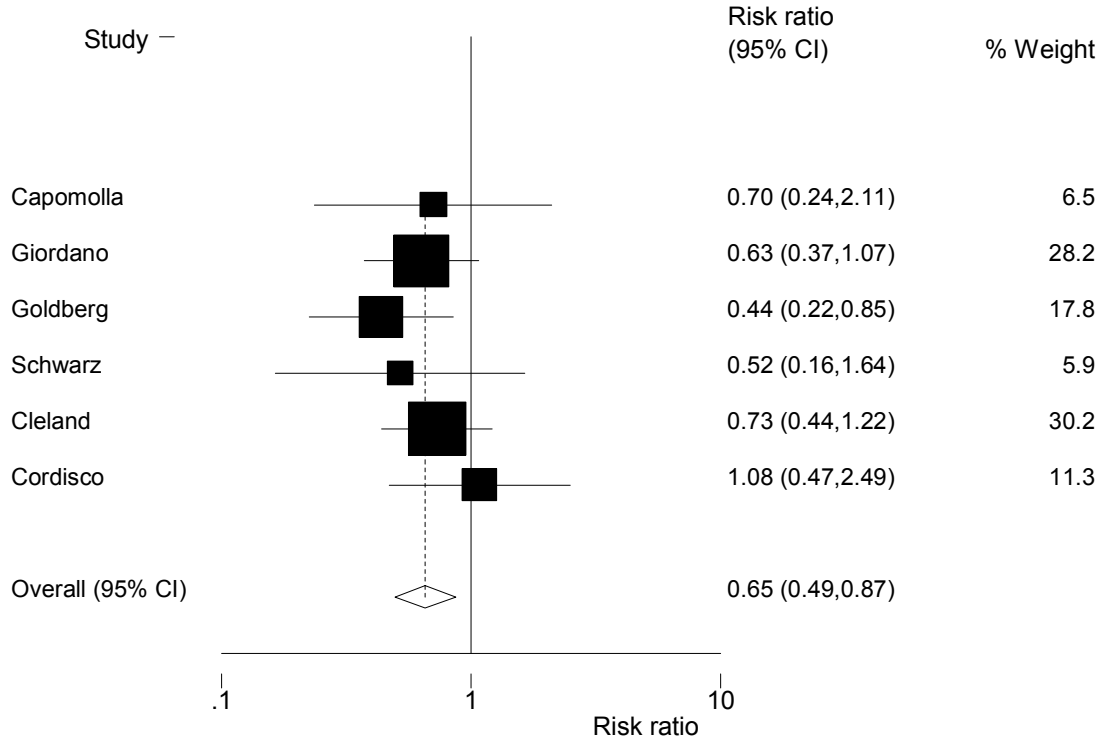


Figure 8: Relative risk of all-cause deaths of HF patients between TS and UC

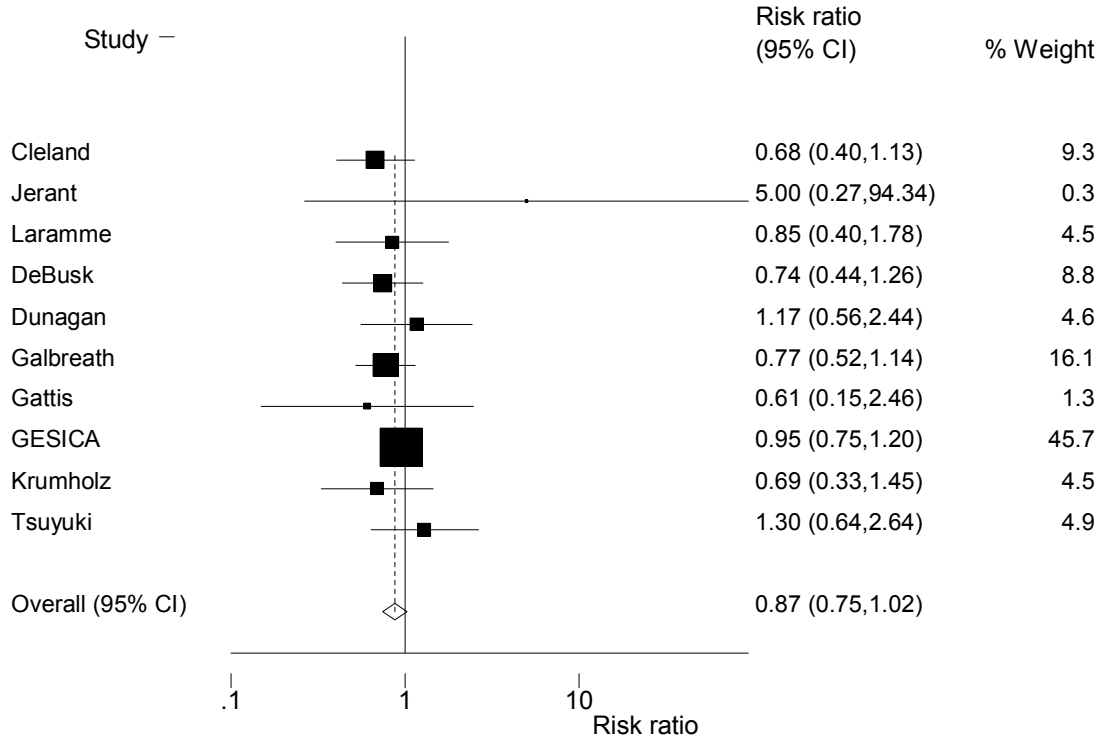


Figure 9: Relative risk of HF-related deaths of HF patients between TS and UC

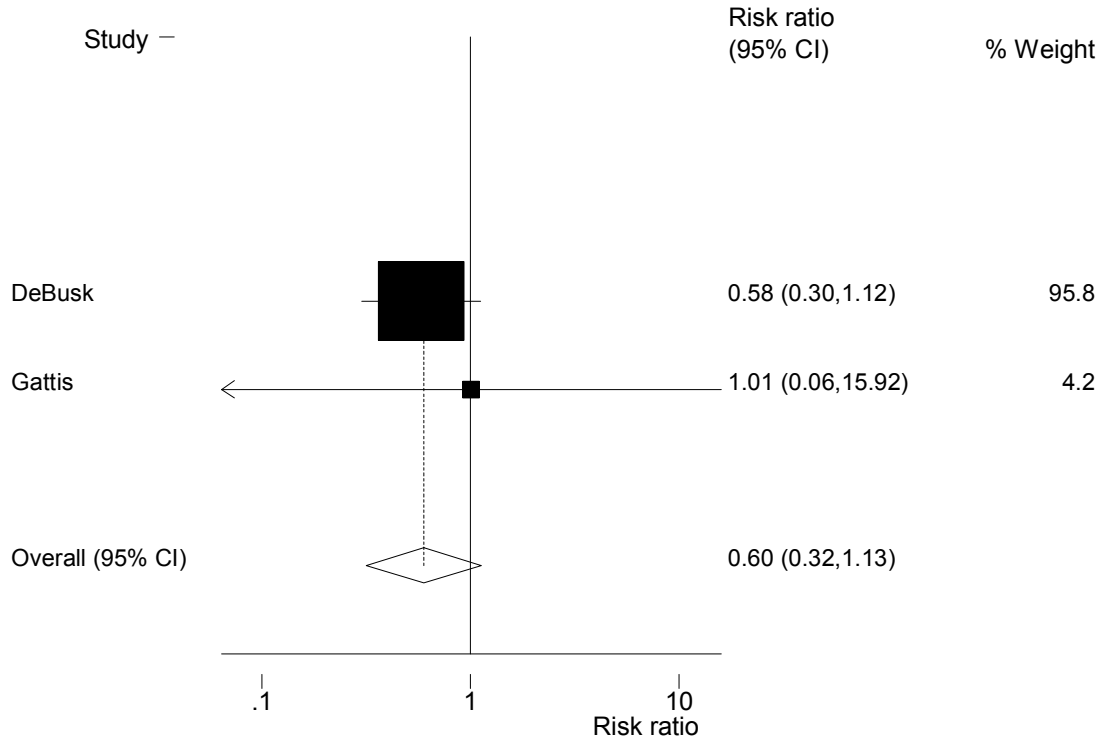


Figure 10: Relative risk of the number of HF patients visiting ED between TS and UC

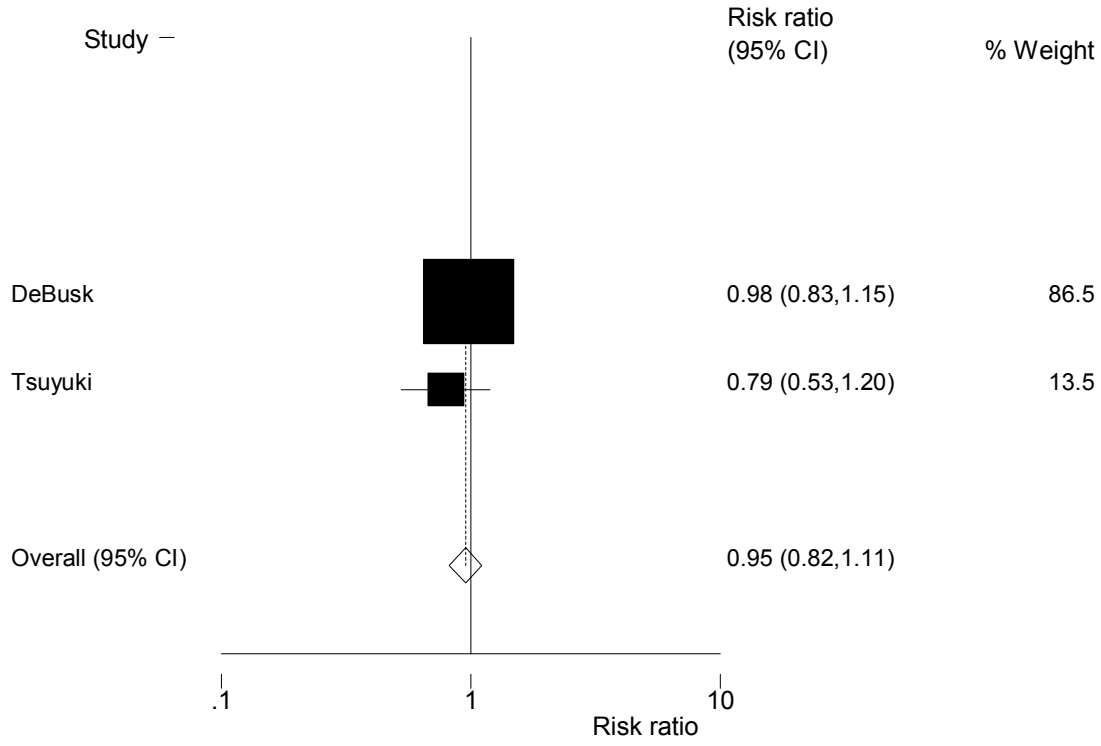


Figure 11: Rate ratios of all-cause hospitalizations between TS and UC

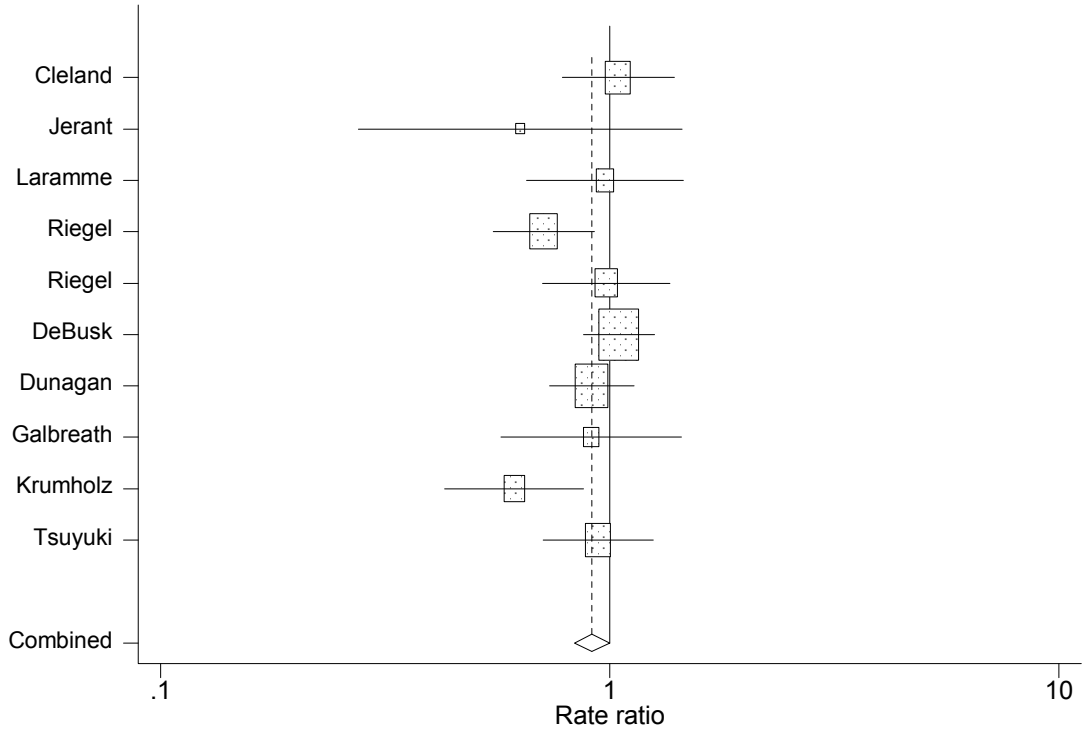


Figure 12: Rate ratios of HF-related hospitalizations between TS and UC

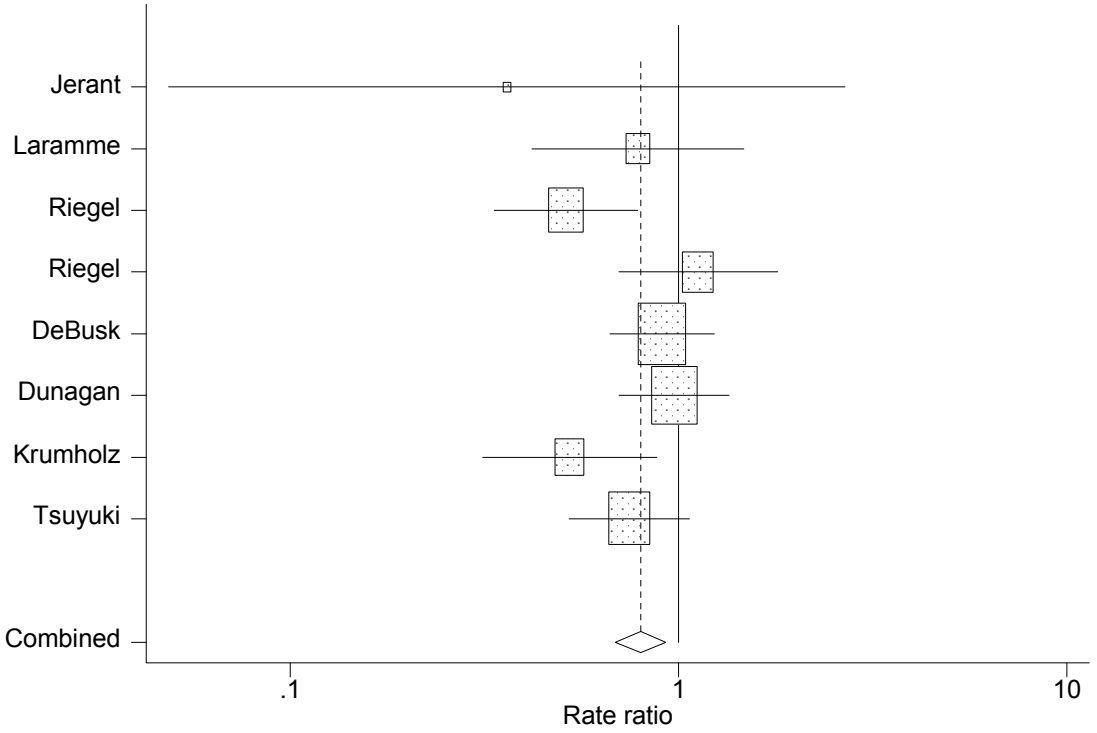


Figure 13: Relative risk of mortality of COPD patients between TS and UC

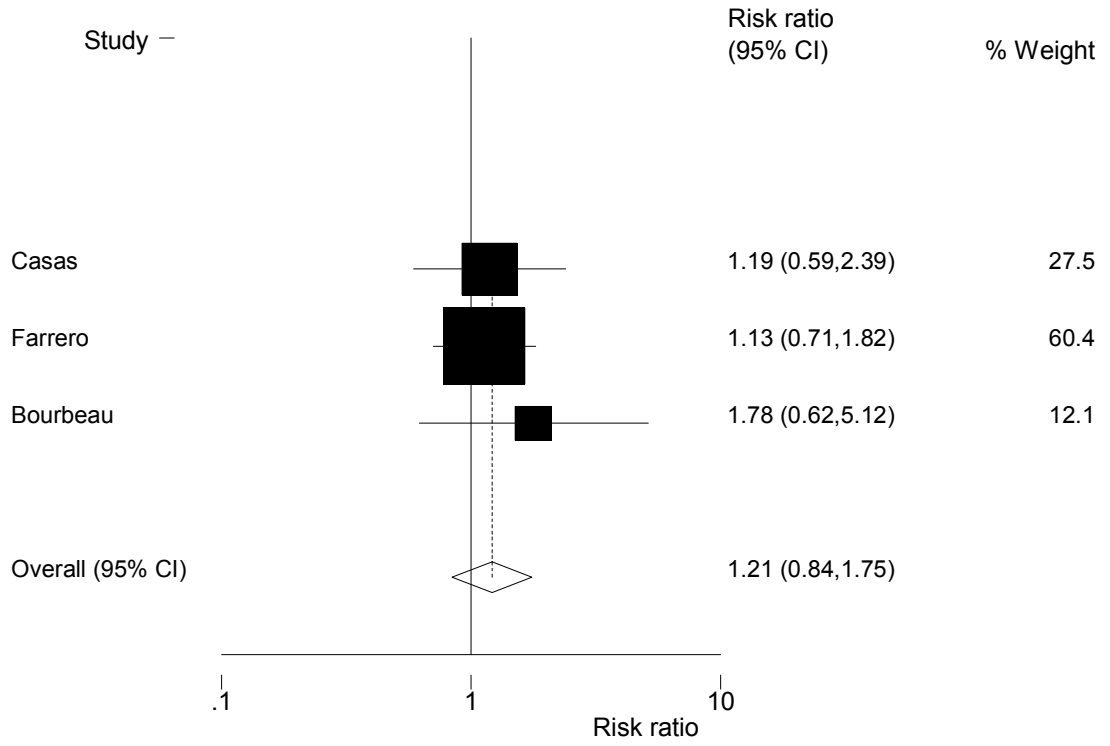


Figure 14: Rate ratio of number of hospitalizations of COPD patients between HTM and UC

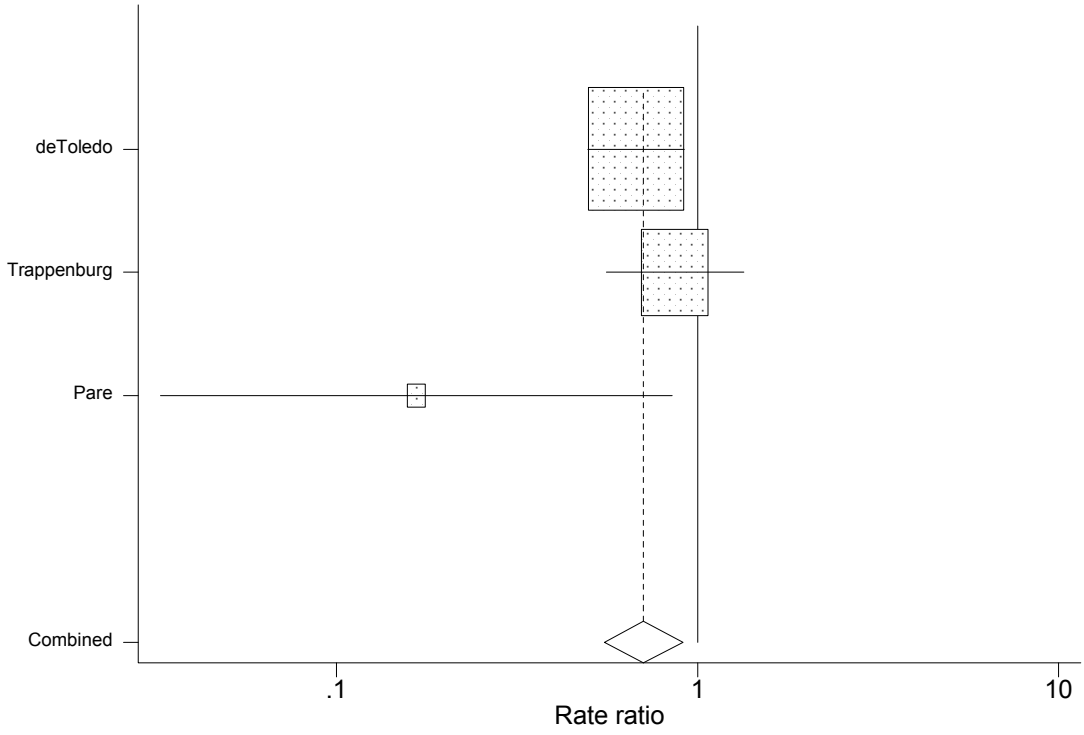


Figure 15: Flow chart for economic considerations

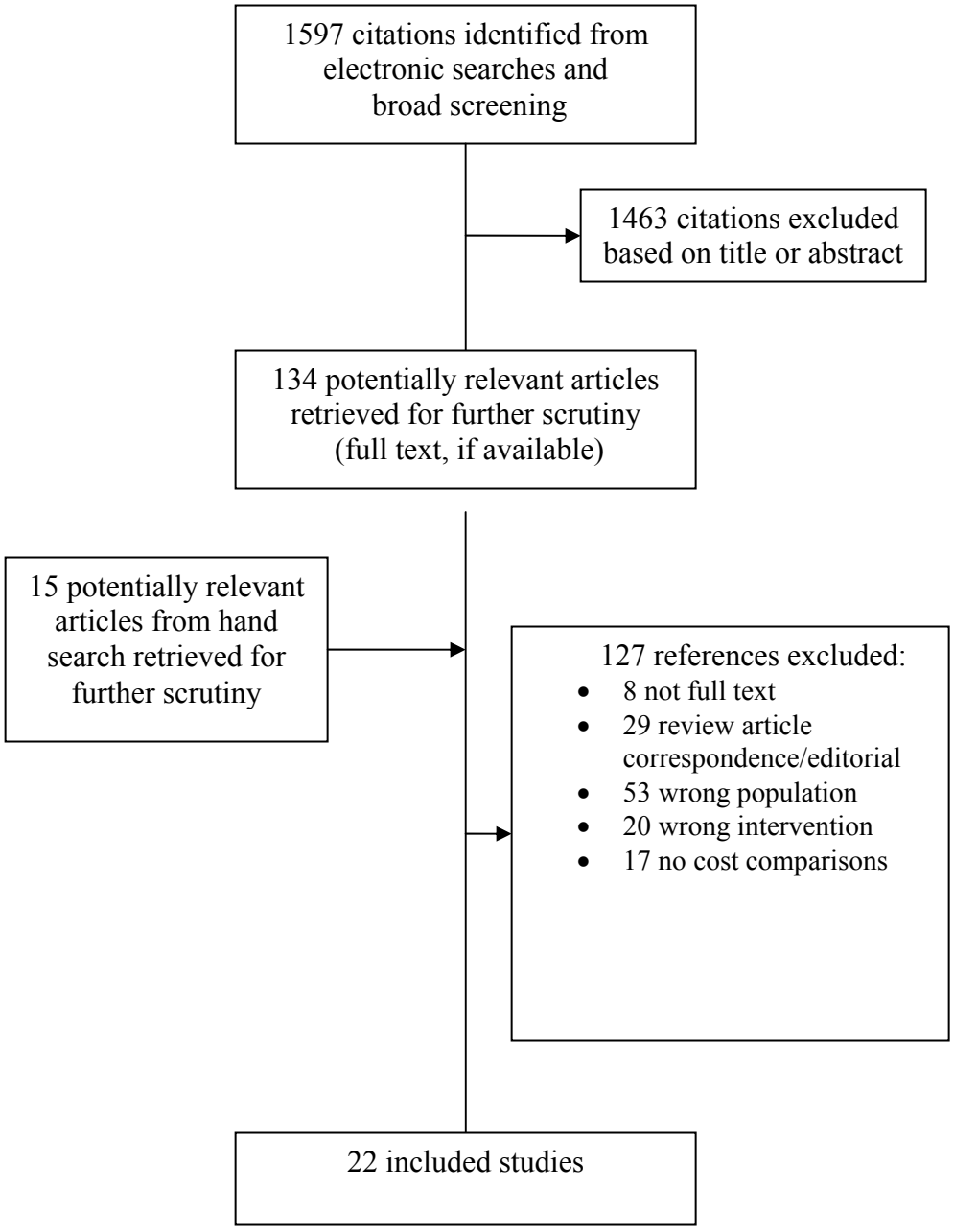
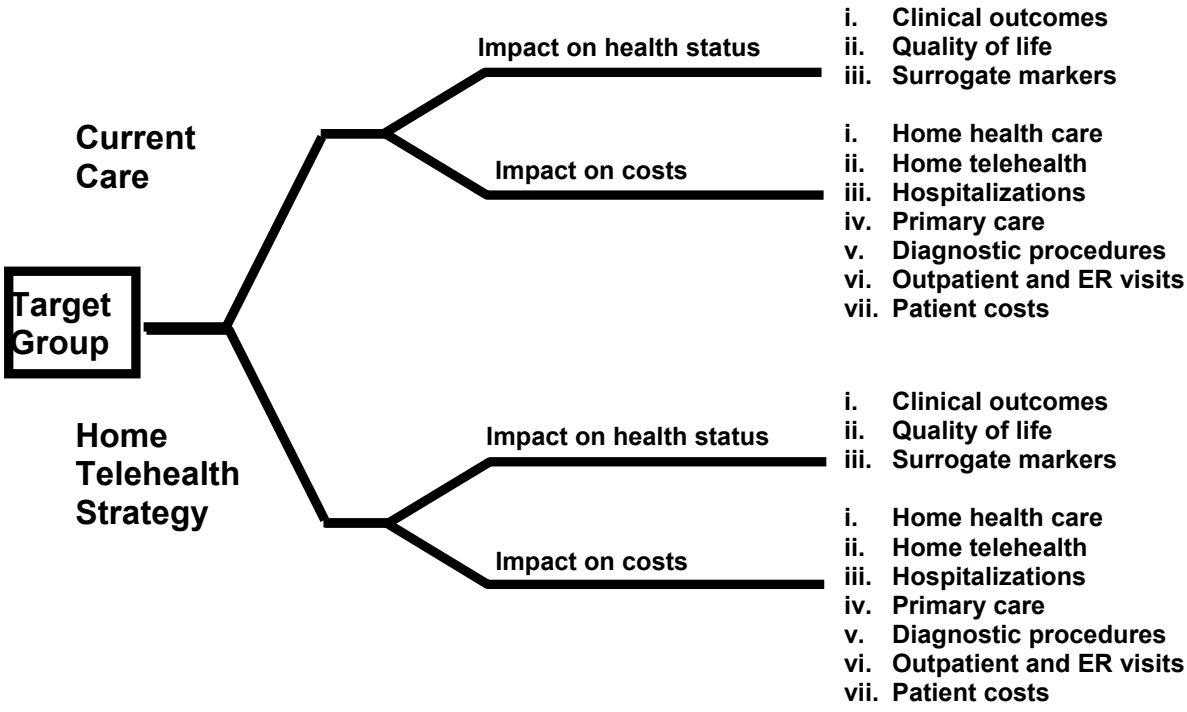


Figure 16: Framework for Economic Evaluation of Home Telehealth Programs



APPENDIX 1: LITERATURE SEARCH STRATEGY

Interface:	Ovid SP, using Ovid Syntax search mode
Databases:	BIOSIS Previews <1989 to 2008 Week 08> CINAHL - Cumulative Index to Nursing & Allied Health Literature <1982 to December Week 1 2007> EMBASE <1988 to 2008 Week 04> Ovid MEDLINE In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) <1950 to Present> Ovid MEDLINE Daily Update <January 31, 2008> PsycINFO <1985 to January Week 5 2008> **Note**: Subject headings have been customized for each database. Duplicates between databases were removed in Ovid. Results from Ovid, Cochrane, and CRD were combined and further duplicates were removed in Reference Manager.
Date of Search:	February 1, 2008
Alerts:	Monthly search updates began February 2008 and ran until July 2008.
Study Types:	No limits by study design for clinical and ethical searches. Economic search includes cost analyses, and other economic studies.
Limits:	Published in the last 10 years. Published in the last 15 years for ethical search.

/	At the end of a phrase, searches the phrase as a subject heading
.sh	At the end of a phrase, searches the phrase as a subject heading
MeSH	Medical Subject Heading
fs	Floating subheading
exp	Explode a subject heading
*	Preceding a subject heading, requires that the subject heading is a primary topic Following a word, acts as a truncation symbol, or wildcard: retrieves plural or variations of a word
/ei	Narrow to subheading Ethics (CINAHL)
/es	Narrow to subheading Ethics (Medline)
/lj	Narrow to subheading Legislation & Jurisprudence (Medline, CINAHL)
?	Truncation or wildcard symbol for one or no characters only
#	Wildcard symbol for one character; can be used in the middle of a word
ADJ#	Adjacency within # number of words (in any order)
.ti	Title
.ab	Abstract
.hw	Heading Word; usually includes subject headings and usual careled vocabulary
.pt	Publication type
.rn	CAS registry number

use	Limits the search to specific databases	
	use prmz	Medline & Medline In Process
	use mesx	Medline Daily Update
	use emed	EMBASE
	use b7o89	BIOSIS
	use nursing	CINAHL
	use psyf	PsycINFO

#	Strategy	Results
Concept 1: Telehome care		
1	Remote Consultation/ use prmz,mesx	2410
2	exp Telemedicine/ and (home* or in-home*).ti,ab,sh. use prmz,mesx,emed,psyf	1406
3	exp Telehealth/ and (home* or in-home*).ti,ab,sh. use nursing	761
4	(telehome* or tele-home*).ti,ab,hw.	168
5	(home* or in-home* or residen*).ti,ab,sh. and (telehealth or tele-health or telecare or tele-care or telemedic* or tele-medic* or telemonitor* or tele-monitor* or teleconsult* or tele-consult* or telematic or tele-matic or telemanagement or tele-management or teleradiology or tele-radiology or telepathology or tele-pathology or teleneurology or tele-neurology or telenursing or tele-nursing or telerehab* or tele-rehab* or teleservic* or tele-servic* or teleconferenc* or tele-conferenc* or telepharmacy or tele-pharmacy or e-health* or ehealth* or m-health*).ti,ab,hw.	3202
6	((home* or in-home* or residen*).ti,ab,sh. and (remote or wireless or mobile).ti,ab.) adj2 (monitor* or consult*).ti,ab,hw.	1268
Telehome care brand names and companies		
7	(home* or in-home* or residen*).ti,ab,sh. and (Aerotel Medical or Aivea or AMD Global Telemedicine or American TeleCare or AvidCare or CardGuard or Card Guard or Cardiocom or Cardionics or Cardiophonics or Carematix or Care2Wear or CareVoyant or Centura or Cifra or Clinidata or CyberCare or Cybernet or DexCom or DiaBetNet or Diabetech or ExceliCare or FireLogic or FONEMED or GlucoCom or GlucoMON or Health Buddy or Health Hero or HealthEngage or Health@nywhere or HomMed or Homecare Homebase or iCare Desktop or IEM GmbHOR or iMetrikus or InforMedix or INRange or Intelsis or Lifewatch or Lifelink or March Networks or McKesson or MDHome or Medic4All or MediCompass or MedNovations or MedShare or Morepress or Neptec or NewIt or Patient Care Technologies or PERS Buddy or Pharos or RemoteAccess or RemoteNurse or Senior Health Advantage Network or Spirotel or T-CARE or Teledoctor or Telehealth Solutions or TeleMedic or Telescale or TouchPointCare or (Tunstall adj3 Genesis) or ViTel Net or VitalNet or Viterion or Well@home or WiPaM).ti,ab,hw.	1537
8	or/1-7	7865
Concept 2: Diabetes, Congestive Heart Failure, and COPD		
9	exp Diabetes mellitus/ use prmz,mesx,emed,nursing	439537
10	exp Diabetes/ use psyf	4908
11	(diabet* or NIDDM or IDDM).ti,ab,hw.	771063
12	exp Heart Failure, Congestive/ use prmz,mesx,emed,nursing	89911
13	((congestive or chronic) adj2 (heart or cardiac or myocard*) adj2 (failure* or decompensation)).ti,ab,hw.	120433

14	CHF.ti,ab.	19675
15	Pulmonary Disease, Chronic Obstructive/ use prmz,mesx	8788
16	Chronic Obstructive Lung Disease/ use emed	24679
17	(chronic adj2 obstruct* adj2 (pulmonary or lung or airway? or airflow or bronchi*)).ti,ab,hw.	67115
18	(COPD or COAD).ti,ab.	34255
19	((chronic adj2 bronchitis) or pulmonary emphysema?).ti,ab,hw.	32613
20	or/9-19	1015906
Concept 3: Economic studies methodology filter (all databases except PsycINFO)		
21	*Economics/ use prmz,mesx,emed,nursing,b8o89	11377
22	*Economics, Medical/ use prmz,mesx	4219
23	*Economics, Pharmaceutical/ use prmz,mesx,nursing	1379
24	*Economics, Hospital/ use prmz,mesx	5423
25	exp "Costs and Cost Analysis"/ use prmz,mesx,nursing	157415
26	exp decision support techniques/ use prmz,mesx	51005
27	exp Budgets/ use prmz,mesx,nursing	11805
28	Cost of illness/ use prmz,mesx,emed	14306
29	exp Models, economic/ use prmz,mesx	5629
30	markov chains.sh. use prmz,mesx	4608
31	monte carlo method.sh. use prmz,mesx,emed	16847
32	uncertainty.sh. use prmz,mesx,emed,nursing	3826
33	Quality-Adjusted Life Years/ use prmz,mesx	3226
34	Value of life/ use prmz,mesx	4882
35	exp Health status indicators/ use prmz,mesx,nursing	110028
36	quality of life/ use prmz,mesx,emed,nursing	164749
37	exp Health economics/ use emed	203300
38	exp "health care cost"/ use emed	93960
39	Budget/ use emed	6995
40	Socioeconomics/ use emed	27201
41	Decision support system/ use emed	1249
42	quality adjusted life year/ use emed	3432
43	"Economic Value of Life"/ use nursing	55
44	Health Resource Allocation/ use nursing	3067
45	Economic Aspects of Illness/ use nursing	1436
46	(econom* or cost or costs or costly or costing or costed or price or prices or pricing or priced or discount or discounts or discounted or discounting or expenditure or expenditures or budget* or afford* or pharmacoeconomic* or pharmaco-economic* or financ*).ti,ab.	961257
47	(cost* adj2 (util* or effective* or efficac* or benefit* or consequence* or analy* or minimi* or saving* or breakdown or lowering or estimate* or variable* or allocation* or usual care* or illness or sharing or life or lives or affordabl* or instrument* or technolog* or day* or fee or fees or charge or charges)).ti,ab.	192223

48	(decision adj2 (tree* or analy* or model*)).ti,ab.	20657
49	((value or values or valuation) adj2 (money or monetary or life or lives or costs or cost)).ti,ab.	8047
50	(qol or qoly or qolys or hrqol or qaly or qalys or qale or qales or qald or qtime or daly or euroqol or eq5d or eq-5d or hql or hqol or h-qol or hrqol or hr-qol or hye or hyes).ti,ab.	39224
51	(markov* or monte carlo).ti,ab.	48927
52	(sensitivity analys#s or "willingness to pay" or quality-adjusted life or quality adjusted life or disability adjusted life or disability-adjusted life).ti,ab.	26982
53	(unit cost or unit-cost or unit-costs or unit costs or drug cost or drug costs or hospital costs or health-care costs or health care cost or medical cost or medical costs).ti,ab.	29971
54	(health adj2 (indicator? or status or utilit?)).ti,ab.	69493
55	or/21-54	1592214
Concept 4: Ethical and privacy concerns		
56	exp Ethics/ use prmz,mesx,emed,nursing,psyf	222037
57	exp Privacy/ use prmz,mesx,emed	9880
58	exp Privacy/ and Confidentiality/ use nursing	7209
59	Computer Security/ use prmz,mesx,emed	4034
60	Data Security/ use nursing	1840
61	exp Jurisprudence/ use prmz,mesx,nursing	160001
62	exp Legal aspect/ use emed	196139
63	exp Legal processes/ use psyf	28941
64	exp Informatics/es, lj use prmz,mesx	114
65	exp Informatics/ei use nursing	145
66	exp Data Collection/es, lj use prmz,mesx	5019
67	exp Data Collection/lj, ei use nursing	133
68	Medical Records Systems, Computerized/es, lj use prmz,mesx	786
69	Computerized Patient Record/lj, ei use nursing	76
70	(ethic* or moral* or bioethic* or e-ethic*).ti,ab,hw.	270951
71	(privacy or confidential* or security or safe*).ti,ab,hw.	974457
72	(legal* or liability or law).ti,ab,hw.	330013
73	(informed adj2 (consent or decision making)).ti,ab,hw.	68514
74	((data or information or informatics or records or record or database*) adj3 (disclosure or compromis* or ownership or property or modification* or policy or policies or protect*)).ti,ab.	23663
75	"secondary use of data".ti,ab.	346
76	or/56-75	1735441
Ethics and Privacy Concerns for Telehome care, last 15 years		
77	limit 8 to yr=1993-2008	7723
78	77 and 76	1018
79	remove duplicates from 78	**843**
Focused Clinical Results: Telehome care for diabetes, CHF, and COPD		
80	limit 8 to yr="1998 - 2008"	6795

81	80 and 20	618
82	remove duplicates from 81	**486**
Focused Economic Results: Telehome care for diabetes, CHF, and COPD		
83	82 and 55	**177**
Overall Clinical Results: Telehome care (not already found in focused clinical search)		
84	80 not 81	**6177**
Overall Economic Results: Telehome care (not already found in focused economic search)		
85	84 and 55	1682
86	remove duplicates from 85	**1420**

PubMed	Same MeSH, keywords, limits, and study types used as per Ovid Medline search, with appropriate syntax used.
Cochrane Library (Wiley InterScience)	Same MeSH, keywords, and date limits used as per Ovid Medline search, excluding study types. Syntax adjusted for Cochrane Library databases.
Centre for Reviews and Dissemination (CRD) Databases	Same MeSH, keywords, and date limits used as per Medline search, excluding study types. Syntax adjusted for CRD databases.

GREY LITERATURE AND HAND SEARCHES

Dates for Search:	January - February 2008
Keywords:	Included terms for home telehealth and its variations (such as telehome, tele-home, e-health, m-health, and terms for home or in-home telehealth, telecare, and telemedicine). Some terms in French were included such as télésoins à domicile, télémédecine (à domicile), and télésanté (à domicile).
Limits:	Published in the last 10 years.

NOTE: This section lists the main agencies, organizations, and websites searched**; it is not a complete list.** For a complete list of sources searched, contact CADTH (http://www.cadth.ca).

Health Technology Assessment Agencies

Alberta Heritage Foundation for Medical Research (AHFMR)
http://www.ahfmr.ab.ca

Agence d'Evaluation des Technologies et des Modes d'Intervention en Santé (AETMIS). Québec
http://www.aetmis.gouv.qc.ca

Canadian Agency for Drugs and Technologies in Health (CADTH)
http://www.cadth.ca

Centre for Evaluation of Medicines. Father Sean O'Sullivan Research Centre,
St.Joseph's Healthcare,Hamilton, and McMaster University, Faculty of Health Sciences. Hamilton, Ontario
http://www.thecem.net/

Centre for Health Services and Policy Research, University of British Columbia
http://www.chspr.ubc.ca/cgi-bin/pub

Health Quality Council of Alberta (HQCA)
http://www.hqca.ca

Health Quality Council. Saskatchewan.
http://www.hqc.sk.ca/

Institute for Clinical Evaluative Sciences (ICES). Ontario
http://www.ices.on.ca/

Institute of Health Economics (IHE). Alberta
http://www.ihe.ca/

Manitoba Centre for Health Policy (MCHP)
http://www.umanitoba.ca/centres/mchp/

Ontario Ministry of Health and Long Term Care. Health Technology Analyses and Recommendations
http://www.health.gov.on.ca/english/providers/program/ohtac/tech/techlist_mn.html

The Technology Assessment Unit of the McGill University Health Centre
http://www.mcgill.ca/tau/

Therapeutics Initiative. Evidence-Based Drug Therapy. University of British Columbia
http://www.ti.ubc.ca

Health Technology Assessment International (HTAi)
http://www.htai.org

International Network for Agencies for Health Technology Assessment (INAHTA)
http://www.inahta.org

WHO Health Evidence Network
http://www.euro.who.int/HEN

Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP-S)
http://www.surgeons.org/Content/NavigationMenu/Research/ASERNIPS/default.htm

Centre for Clinical Effectiveness, Monash University
http://www.med.monash.edu.au/healthservices/cce/

Medicare Services Advisory Committee, Department of Health and Aging
http://www.msac.gov.au/

Institute of Technology Assessment (ITA)
http://www.oeaw.ac.at/ita/index.htm

Federal Kenniscentrum voor de Gezendheidszorg
http://www.kenniscentrum.fgov.be

Danish Centre for Evaluation and Health Technology Assessment (DCEHTA). National Board of Health
http://www.dihta.dk/

DSI Danish Institute for Health Services Research and Development
http://www.dsi.dk/engelsk.html

Finnish Office for Health Care Technology and Assessment (FinOHTA). National Research and Development Centre for Welfare and Health
http://finohta.stakes.fi/EN/index.htm

L'Agence Nationale d'Accréditation et d'Evaluation en Santé (ANAES). Ministere de la Santé, de la Famille, et des Personnes handicappés
http://www.anaes.fr/anaes/anaesparametrage.nsf/HomePage?ReadForm

Committee for Evaluation and Diffusion of Innovative Technologies (CEDIT)
http://cedit.aphp.fr/english/index_present.html

German Institute for Medical Documentation and Information (DIMDI). Federal Ministry of Health
http://www.dimdi.de/static/de/hta/db/index.htm

College voor Zorgverzekeringen/Health Care Insurance Board (CVZ)
http://www.cvz.nl

Health Council of the Netherlands
http://www.gr.nl

New Zealand Health Technology Assessment Clearing House for Health Outcomes and Health Technology Assessment (NZHTA)
http://nzhta.chmeds.ac.nz/

Norwegian Centre for Health Technology Assessment (SMM)
http://www.kunnskapssenteret.no/

Agencia de Evaluación de Tecnologias Sanitarias (AETS), Instituto de Salud "Carlos III"/ Health Technology Assessment Agency
http://www.isciii.es/htdocs/investigacion/Agencia_quees.jsp

Basque Office for Health Technology Assessment (OSTEBA). Departemento de Sanidad
http://www.osasun.ejgv.euskadi.net/r52-2536/es/

Catalan Agency for Health Technology Assessment and Research (CAHTA)
http://www.gencat.net/salut/depsan/units/aatrm/html/en/Du8/index.html

CMT - Centre for Medical Technology Assessment
http://www.cmt.liu.se/pub/jsp/polopoly.jsp?d=6199&l=en

Swedish Council on Technology Assessment in Health Care (SBU)
http://www.sbu.se/

Swiss Network for Health Technology Assessment
http://www.snhta.ch/about/index.php

European Information Network on New and Changing Health Technologies (EUROSCAN). University of Birmingham. National Horizon Scanning Centre
http://www.euroscan.bham.ac.uk

National Horizon Scanning Centre (NHSC)
http://www.pcpoh.bham.ac.uk/publichealth/horizon

NIHR Health Technology Assessment programme, Coordinating Centre for Health Technology Assessment (NCCHTA)
http://www.hta.ac.uk/

NHS National Institute for Clinical Excellence (NICE)
http://www.nice.org.uk

NHS Quality Improvement Scotland
http://www.nhshealthquality.org

University of York NHS Centre for Reviews and Dissemination (NHS CRD)
http://www.york.ac.uk/inst/crd

The Wessex Institute for Health Research and Development. Succinct and Timely Evaluated Evidence Review (STEER)
http://www.wihrd.soton.ac.uk/

West Midlands Health Technology Assessment Collaboration (WMHTAC)
http://www.wmhtac.bham.ac.uk/

Agency for Healthcare Research and Quality (AHRQ)
http://www.ahrq.gov/

Dept. of Veterans Affairs Research & Development, general publications
http://www1.va.gov/resdev/prt/pubs_individual.cfm?webpage=pubs_ta_reports.htm

VA Technology Assessment Program (VATAP)
http://www.va.gov/vatap/

ECRI
http://www.ecri.org/

Institute for Clinical Systems Improvement
http://www.icsi.org/index.asp

Technology Evaluation Center (TEC). Blue Cross Blue Shield Association
http://www.bcbs.com/blueresources/tec/

University HealthSystem Consortium (UHC)
http://www.uhc.edu/

Health Economic

Bases Codecs. CODECS (COnnaissances et Décision en EConomie de la Santé) Collège des Economistes de la Santé/INSERM
http://infodoc.inserm.fr/codecs/codecs.nsf

Centre for Health Economics and Policy Analysis (CHEPA). Dept. of Clinical Epidemiology and Biostatistics. Faculty of Health Sciences. McMaster University, Canada
http://www.chepa.org

Health Economics Research Group (HERG). Brunel University, U.K.
http://www.brunel.ac.uk/about/acad/herg

Health Economics Research Unit (HERU). University of Aberdeen
http://www.abdn.ac.uk/heru/

Health Economic Evaluations Database (HEED)
http://heed.wiley.com

The Hospital for Sick Children (Toronto). PEDE Database
http://pede.bioinfo.sickkids.on.ca/pede/index.jsp

University of Connecticut. Department of Economics. RePEc database
http://ideas.repec.org

Conferences and Meetings
Searched for 1998-2008 where available.

TeleHealth 2007: "Telemedicine and innovative technologies for chronic disease management"
December 11, 2007, Brussels, Belgium
http://ec.europa.eu/information_society/events/telehealth_2007/docs/2007th-conf-rep_final.pdf

MEDINFO (International Medical Informatics Association)
No static website.

American Medical Informatics Association (AMIA) Meetings
http://www.amia.org/meetings/

American Telemedicine Association (ATA) Meetings
http://www.atmeda.org

Organizations and Directories - Canadian

Canadian Society of Telehealth
http://www.cst-sct.org/en/

Industry Canada: E-Health and Telehealth
http://www.ic.gc.ca/epic/site/ict-tic.nsf/en/h_it06135e.html
and the E-Health / Telehealth Directory http://www.ic.gc.ca/epic/site/ict-tic.nsf/en/h_it06135e.html

Organizations and Directories - International

Telemedicine Information Exchange (TIE)
http://tie.telemed.org/

American Telemedicine Association
http://www.americantelemed.org/

Search Engines

Google
http://www.google.ca/

Yahoo!
http://www.yahoo.com

APPENDIX 2: DATA EXTRACTION FORM

Study						
First author, year of publication, (RefID)						
Study Characteristics						
Objective						
Disease type						
Publication type						
Sponsor						
Countries						
No of centers						
Study design						
Comparison arms						
Description of intervention and comparator (technologies)						
Strategies for integration of home telehealth into existing models						
Criteria and tools to identify patients for home telehealth						
Type and number of health care workers required						
Length of follow-up (months)						
Number of patients assigned (n)						
Number of patients completed trials (n)						
Number of withdrawals (n)						
Quality Assessment						

Author, year (RefID)	**Score**
Study design	
1. Large RCT (Over 50 in each arm): 5 points	
2. Small RCT: 3 points	
3. Prospective: 2 points	
4. Retrospective: 1 point	
If RCT*:	
a. Randomization appropriately described?	
b. Blinded?	

c. Blinding appropriately described?	
* An RCT gets full points if addressed all 3 characteristics. Half a point is deducted for each characteristic not addressed.	
Study performance	
Score (Info missing 0 point, Info limited 1 point, Info satisfactory 2 points)	
1. Patient selection	
2. Description/specification of the intervention	
3. Specification and analysis of study (intention-to-treat)	
4. Patient disposal	
5. Outcomes reported	
Overall Score	
Category	
A (overall score 11.5-15.0): High quality – high degree of confidence in study findings B (overall score 9.5-11.0): Good quality – some uncertainty regarding the study findings C (overall score 7.5-9.0): Fair to good quality – some limitations that should be considered in any implementation of study findings D (overall score 5.5-7.0): Poor to fair quality – substantial limitations in the study; findings should be used cautiously E (overall score 1-5.0): Poor quality – unacceptable uncertainty for study findings	

Patient baseline characteristics						
Comparison arms						
Inclusion						
Exclusion						
Age (y), mean ± SD						
Gender, male/female (%)						
BMI (kg/m^2)						
Duration of disease (years), mean ± SD						
HbA1c (%)						
FEV1 (%)						
NYHA class (for heart failure)						
2 (%)						
3 (%)						
4 (%)						
Education						
Total (years)						
Less than high school						
High school and beyond						
Comorbidity index (mean)						

Number of hospitalizations/re-admissions						
All cause						
Disease related						
Hospital stay (days)						
All cause						
Disease related						
Number of outpatient visits						
Number of primary care physician visits						
Number of specialist physician visits						
Number of ED visits						
All cause						
Disease related						
Outcomes						
Comparison arms						
No. of pts considered for outcomes (N)						
Primary						
Number of patients re-admitted						
Number of hospitalizations/re-admissions (per patient)						
All cause						
Disease related						
% of patients with ≥1 hospitalizations						
All cause						
Disease related						
Hospital stay (days) per patient						
All cause						
Disease related						
Number of emergency room visits per patient						
All cause						
Disease related						
Number of office visits per patient						
Family practitioner						
Specialist						

Nurse and other						
Total						
Number of home visits per patient						
Family practitioner						
Specialist						
Nurse and other						
Total						
Secondary						
HbA1c (%)						
Number of deaths						
Quality of life:						
Comparison arms						
No. of pts considered for outcomes (N)						
Type of instrument used						
General health						
Physical health						
Bodily pain						
Vitality						
Emotional						
Mental health						
Cognitive outcomes						
Quality						
Perceptions						
Satisfaction						
Depression						
Knowledge score						
Self-care behaviour						

APPENDIX 3A: INCLUDED CLINICAL STUDIES

A. Diabetes (26)

First author	Reference
Barnett (2006)[22]	Barnett TE, Chumbler NR, Vogel WB, Beyth RJ, Qin H, Kobb R. The effectiveness of a care coordination home telehealth program for veterans with diabetes mellitus: a 2-year follow-up. *Am J Manag Care* 2006;12(8):467-74. Available: http://www.ajmc.com/files/articlefiles/AJMC_06augBarnett467to474.pdf (accessed 2008 Feb 12).
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Harno (2006) [28]	Harno K, Kauppinen-Makelin R, Syralainen J, Managing diabetes care using an integreated regional e-health approach. Journal fo Telemedicine and Telecare 2006; 12(Suppl. 1): S1:13-15
Jansà (2006)[29]	Jansà M, Vidal M, Viaplana J, Levy I, Conget I, Gomis R, et al. Telecare in a structured therapeutic education programme addressed to patients with type 1 diabetes and poor metabolic usual care. *Diabetes Res Clin Pract* 2006;74(1):26-32. Available: http://www.crd.york.ac.uk/CRDWeb/ShowRecord.asp?ID=22006002520 Record #4.
Kim (2003)[43]	Kim HS, Oh JA. Adherence to diabetes usual care recommendations: impact of nurse telephone calls. *J Adv Nurs* 2003;44(3):256-61.
Kim (2005)[30]	Kim HS, Yoo YS, Shim HS. Effects of an Internet-based intervention on plasma glucose levels in patients with type 2 diabetes. *J Nurs Care Qual* 2005;20(4):335-40.
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B. Heart failure (35)

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Artinian (2003)[48]	Artinian NT, Harden JK, Kronenberg MW, Vander Wal JS, Daher E, Stephens Q, et al. Pilot study of a Web-based compliance monitoring device for patients with congestive heart failure. *Heart & Lung* 2003;32(4):226-33.
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	Jerant AF, Azari R, Martinez C, Nesbitt TS. A randomized trial of telenursing to reduce hospitalization for heart failure: patient-centered outcomes and nursing indicators. *Home Health Care Serv Q* 2003;22(1):1-20.
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C. COPD (9)

First author	Reference
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D. Mixed chronic diseases (8)

First author	Reference
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APPENDIX 3B: INCLUDED REPORTS ON ETHICAL AND LEGAL CONSIDERATIONS

First author	Reference
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[237]	*Reibl v. Hughes*, [1980] 2 S.C.R. 880.
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APPENDIX 4A: STUDY CHARACTERISTICS (DIABETES)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Barnett, 2006[22]; Retrospective, concurrent matched cohort	To assess health care use among veterans with diabetes mellitus (DM) enrolled in a Dept. of Veterans Affairs care coordination home telehealth program during 24 months and to contrast this utilization with the service use of a comparison group of veterans with DM, not enrolled in the program	2 years	USA; 4 centres; Government	Home telehealth	Messaging device (Telephone and electrical outlet): Patients answered scripted questions about their daily DM symptoms and health status Nurse care coordinators (RN or advanced RN practitioners): monitored responses daily and made clinical judgements; performed patient assessment, placed new orders for medications, helped patients manage medications, scheduled new appointments with clinics, gave appointment reminders, and assisted with technological difficulties. Each telephone call approximately 15 to 30 min. Telemonitor and videophone: with 2-way audio/video connectivity: for weekly contact (rarely used)	400/9
				Not in program		400/9
Biermann, 2002[23]; RCT	To assess the fiscal and administrative aspects of telemanagement of diabetes patients	4 months	Germany; 1 centre; Industry (MediSense/Abbott)	Home telemonitoring	Patients determined their blood glucose values by using memory meters, which connected to the pre-programmed modem. The modem automatically uploaded the data via the analog telephone system to the diabetes centre. Patients could contact the centre via a 24-hr voice recorder system.	30/3
				Usual care	Patients received usual care from their physicians	18/2
Bujnowska-Fedak, 2006[24]; Prospective controlled study	To evaluate a telemedicine support system for diabetes management and to compare it with standard	6 months	Poland; Centres NR; NHS Modernization fund, Mersey Primary	Home telehealth	Telemedicine systems: a Patient Unit and a Medical Unit connected by a computer network. Patients needed to have a personal computer (PC) with internet access at home. Patients downloaded data from the blood	30/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	monitoring of patients with diabetes		Care R&D Consortium, and Astra Zeneca		glucose monitoring device in to the PC via an infrared link and sent all results at least once a day via the internet to the family physician.	
				Traditional method	Patients measured their blood glucose with the glucometer according to their own schedule and consulted with the family physician at least once a month.	30/NR
Chase, 2003[25]; RCT	To determine whether modem technology allows for effective management of type 1 diabetes when used in lieu of a clinic visit	6 months	US; 1 centre; Government, Industry (Roche), and Children's Diabetes Foundation	Modem transmission review and telephone follow-up	Patients had 2 clinic visits. Patients electronically transmitted their blood glucose information to the clinic every 2 weeks. A health care provider (registered nurse or doctor) reviewed each transmission and called the patient to discuss and make treatment changes as needed.	35/5
				Usual care	Patients had 3 clinic visits, with the option to telephone or fax blood glucose results to the clinic.	35/2
Chumbler, 2005[26]; Pre-post study	To evaluate a Veterans Health Administration care coordination/home telehealth program on the utilization of health care services and health-related quality of life (HROQL) in veterans with diabetes	1 year	US; 4 centres; Veterans Affairs	Home telehealth	Technologies: In-home messaging device with disease management dialogues; telemonitor with 2-way audio-video connectivity for weekly monitoring of glucose and vital signs; videophone with 2-way audio-video connectivity with no biometric monitoring. Patients answered questions daily from the in-home messaging device. The care coordinator received these responses and determined the level of risk for health care emergency.	537/92
				Pre-home telehealth	NR	
Dang, 2007[27]; Pre-post study	To evaluate telemedicine in diabetes management	9 months	US; Centres NR;	Home telehealth	Telephone-based, in-home messaging device used for patient monitoring and education.	41/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	and education in older adults from different ethnic backgrounds		Veterans Affairs		Patients input their responses to questions regarding blood sugar and answered educational questions. A modem in the messaging device transmitted the data to a centre, where patient responses were stratified into high, medium and low risk, based on preset values. Data were available to the care coordinators via a secure Internet web site.	
				Pre-home telehealth	NR	
Harno, 2006[28]; RCT	To study diabetes care with diabetes management system, including care link, and whether improved diabetes usual care could be achieved with fewer visits compared with usual care	1 year	Finland; 4 centres; Sponsor NR	Home telehealth	E-health application with diabetes management system (DMS) and a home care link. Patients had one educational visit (to set up home care link). Patients downloaded their measurements directly from the blood glucose meter into regional database using a modem. The self-management system allowed the diabetes team to transmit text messages to patients with mobile phones and internet access. Data protection was handled by secure socket layer encryption. The care team was able to access the home diary with the patient's consent.	101/0
				Usual care	Regular general practitioner visits about every 3 months. Frequent visits were not denied if clinically necessary.	74/0
Jansa, 2006[29]; RCT	To assess the effects of telecare on the results of intense follow-up in type 1 diabetic patients with poor metabolic usual care	6 months	Spain; 1 centre; Government	Home telecare	GlucoBeep Patient Device connected to glucose meter, electronically sent glycemia values electronically, after which patient could leave a voice message about insulin doses and events. Data were encoded and stored in the server, then unloaded by the diabetes team, which provided appropriate counselling. Patients had 12 appointments: 9	20/4

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					telematic with the GlucoBeep system + 3 outpatient	
				Conventional	Patients had 12 outpatient appointments	20/6
Kim, 2003[43]; RCT	To investigate the effect of nurse telephone calls on HbA1c levels and adherence to diabetes usual care recommendations	12 weeks	South Korea; 1 centre; Government	Telephone intervention	Education and reinforcement of diet, exercise, medication adjustment recommendations, as well as frequent self-monitoring of blood glucose levels. Patients wrote self-management logs on blood glucose levels, diet and exercise. A dietician analyzed the diet diaries and medication adjustments were made by the researcher. Telephone intervention was given twice a week for the first month and then weekly for the second and third month.	25/5
				Routine care	Visit to physician every 3 months	25/9
Kim, 2005[30]; Pre-post study	To evaluate whether a nurse intervention using short messaging service by cellular phone and wire internet would improve the blood glucose and serum lipid levels and care satisfaction in type 2 diabetes mellitus patients.	12 weeks	South Korea; 1 centre; Korea Science and Engineering Foundation	Post (cellular phone and internet)	Patients logged in the web site, using cellular phone or wire internet, where they input and sent data of self-monitored blood glucose levels and drug information. The researcher or nurse viewed the patient's information and sent optimal recommendations to each patient by cellular phone or the internet.	45/3
				Pre	NR	
Kwon, 2004[31]; RCT	To determine the effectiveness of an internet-based blood glucose monitoring system on usual care the changes in HbA1c	12 weeks	Korea; 1 centre; Government	Internet-based blood glucose monitoring system	Patients contacted website and sent information about their self-monitored blood glucose levels and drug information. Patients also could record changes in blood pressure or weight and any questions or detailed information. After reviewing all information, physicians sent optimal recommendations	55/4

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					back to each patient. Contact was only through the internet (no telephone contact).	
				Usual care	Patients visited the diabetes centre monthly and received their usual outpatient treatment from their physicians	55/5
Ladyzynski, 2007[32]; RCT	To examine the influence of the increased frequency of data reporting on metabolic usual care in patients with type 1 diabetes	Approx. 6 months	Poland; Centres NR; Government and Industry (Bayer Diagnostic Division Warsaw Ltd and PTK Centertel Ltd)	Home telecare	Each patient was equipped with a transmission module consisting of a blood glucose meter/electronic logbook and a modem for connection to the telephone network. Collected data were transmitted to the hospital daily, enabling more frequent interventions by the doctor. Clinical examinations were performed every 3 weeks	15/NR
				Usual care	Clinical examinations were performed every 3 weeks	15/NR
Larizza, 2006[33]; Prospective study	To determine the feasibility and effectiveness of an asynchronous telemedicine service (M^2DM) in the management of diabetes mellitus	12 months	Italy; 2 centres; Government	Home telehealth	The M2DM was based on a Multi-Access Services architecture, which integrated web and telephone access through interactive voice response systems for patients and physician. Patients took their blood glucose measurements at home with a meter, then transmitted data via a smart modem. Data were received and stored in the central database and automatically analyzed. The physician reviewed data and modified therapy as necessary. Communications were via email. Patients also visited the outpatient centre every 3 months if possible.	38/8
				Usual care	Details NR. Patients visited the outpatient centre every 3 months if possible.	30/4
Liesenfeld, 2000[34]; Pre-post study	To evaluate the telemedical care program in improving glycemic usual care in children and	19 weeks average (6-48)	Germany; 1 centre; Government and Industry (Roche)	Post (Telecare)	Diabetologist communicated with patients only via telephone. Patients measured blood glucose at least 4 times daily using a hand-held glucose meter with memory storage, and	61/7

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	adolescents with type I diabetes				transferred data via the modem of the palmtop computer over telephone lines to a remote computer in the diabetes centre, at least once a week. Diabetologist in the center viewed the data and initiated the telephone counselling with the patient or the caretaker to discuss treatment goal for a 3-month period. Frequent data transmissions and individual telephone contacts were performed to obtain the treatment goal.	
				Pre Telecare	Most patients had been treated by local general practitioners or internists.	
Maljanian, 2005[44]; RCT	To evaluate the value of intense telephone follow-up as an additional component of a diabetes disease management program in improving glycemic usual care, adherence with standards of care and health-related quality of life	12 months	US; 1 centre; Aetna	Telephone monitoring	Patients received usual of care plus 12 weekly telephone calls to reinforce education and self-management skills.	Both arms 507/171
				Usual care	Patients received usual of care	
McMahon, 2005[35]; RCT	To assess the effects of web-based care management on glucose and blood pressure usual care over 12 months in patients with poorly usual careled diabetes	12 months	US; 1 centre; Government	Web-based care management	Patients received usual care, a notebook computer, a glucose meter and a blood pressure monitor. The notebook computer was programmed to connect to a diabetes education and management website. Patients received computer training and support from one of the staff. Patients uploaded data from the blood pressure and glucose monitoring devices to the website, which displayed the data graphically and in tabular form for the patients and care manager to review. The care manager responded to queries within 1 working day during office hours. The care	52/8

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					manager and primary care providers communicated mainly via e-mail. Physicians made changes in medication directly into the pharmacy's electronic ordering system.	
				Usual care	Ongoing care by the patients' primary physicians	52/12
Warren, 2000[36]; RCT	To study whether telemedicine can improve a patient's ability to self-manage type 2 diabetes	3 months	US; 1 centre; Government	Home telehealth	Physicians made all diabetic management decisions. Care manager reinforced care plans and consulted with physicians weekly. Case manager, clinical coordinator and/or technician visited patient's home, installed the unit, and instructed patient on the use of equipment. Patients enroll in the multidisciplinary diabetic education class. Case manager counselled patients on weekly scheduled visits, to review data, nutritional goals, and well-being from previous week. Case manager recommended nutritional and exercise alternatives and reinforced medication compliance. E-mail contact was maintained between case manager, internist, family practitioner on patient's status, progress and medication. Two physicians also connected via telemonitoring unit once a month and evaluated patients at home. Case manager participated in patient-physician sessions. **Equipment:** Aviva 10/10 SL units with audio/video conferencing and medical equipment. **Technical platform**: clinician's workstation, patient home units, and the software application to collect and report patient data.	15/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care (routine care)	Routine usual of care. Patients enrolled in the multidisplinary diabetic education class. Continued scheduling regular visits with either the family practice or internal medicine physician.	13/0
Meneghini, 1998[37]; Pre-post study	To evaluate the usage and safety of an electronic case manager (ECM) system designed to facilitate glycemic usual care.	12 months	US; 1 centre; Diabetes Research Institute Foundation	Post (internet-based home telehealth)	The ECM is based on a personal computer platform, consisting of one interface for the physician or case manager and the other for the patient, connected via a telephone line. Patients entered blood glucose measurements, lifestyle events and other indexes. Electronic reports derived from these data were automatically prepared and available for the health care professional to review. The health care professional could leave a voice mail message for patients regarding specific instructions.	184/77
				Pre	NR	
Piette, 2000[45]; RCT	To evaluate the impact of automated telephone disease management calls with telephone nurse follow-up as a strategy for improving outcomes such as mental health, self-efficacy, satisfaction with care, and health-related quality of life among low-income patients with diabetes.	12 months	US; 2 centres; American Diabetes Association; Dept of Veterans Affairs	Automated telephone disease management	Automated statements and queries recorded in human voice transmitted to patients biweekly, lasting 5 to 8 minutes, placed at a convenient time for participants and required entering of participation number. Questions about blood glucose monitoring, symptoms, problems related to diabetes, as well as diabetic management were asked. Patients were instructed to call 911 or their physician immediately if there was chest pain or severe breathing. Patients were encouraged to call the study nurse if they had health problems or questions not covered in the assessment. Each week, the nurse used protocols and guidelines to assess the patients' reports and prioritize her patient contacts.	140/13

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care	Patients received usual care and had no contact with the ATDM system for clinical assessments, patient education, appointment reminders, or follow-up data collection.	140/19
Piette, 2001[38]; RCT	To evaluate automated telephone disease management (ATDM) with telephone nurse follow-up as a strategy for improving processes and outcomes in Department of Veterans Affairs clinics	12 months	US; 4 centres; Government	Automated telephone disease management (ATDM)	Statements and queries recorded in human voice. Calls were biweekly, lasted 5 to 8 minutes each, were placed at the convenient time of participants and required entering of participation number. During each assessment, questions about blood glucose monitoring, symptoms, problems related to diabetes, and diabetic management were asked. Patients were instructed to call 911 or their physician immediately if there was chest pain or severe breathing. At the end of each call, patients were encouraged to call the study nurse if they had health problems or questions not covered in the assessment. Each week, the nurse used protocols and guidelines to assess the patients' reports and prioritize her patient contacts.	146/14
				Usual care	Patients had no contact with the ATDM system for clinical assessments, patient education, appointment reminders, or follow-up data collection.	146/6
Shea, 2006[39]; RCT	To compare telemedicine case management to usual care	12 months	US; Multi-centre; Government	Home telehealth	The home telemedicine unit (HTU) consisted of a web-enable computer with modem connection to a telephone line. The HTU provided 4 major functions: (1) videoconferencing, (2) remote monitoring of glucose and blood pressure, (3) dial-up internet service provider access to a web portal providing access to patients' own clinical data and secure web-based	844/144

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					messaging with nurse case managers, (4) access to educational web site. Patients were trained in the use of the HTU and assigned to a project case manager under supervision of diabetologists. The primary care physicians provided care to their patients. The diabetologist reviewed the case managers' notes and when there was a change in management, the primary physician was contacted by e-mail, fax, letter or phone	
				Usual care	Patients received care from their primary care providers.	821/104
Thompson, 1999[46]; RCT	To determine whether the addition of regular telephone contact via a diabetes nurse educator would lead to improvements in levels of HbA1c in patients with poor glucose usual care	6 months	Canada; 1 centre; Industry (Eli Lilly)	Telephone contact	Patients made arrangements for regular telephone contact with the nurse as needed; average 3 calls per week, each lasting 15 minutes. Most calls involved insulin adjustment. The nurse reviewed patients' records with their physicians as needed (approx every 2 weeks).	23/0
				Usual care	Patients continued their usual contact with the endocrinologist at the clinic for insulin adjustment, with HbA1c measured every 3 months.	23/0
Tsang, 2001[40]; Randomized, crossover study	To examine the effect of a computerized diabetes monitoring system (DMS) that conveyed dietary information, in glycemic usual care in diabetes patients	6 months (3 months each arm)	China; 1 centre; Government	Hand-held diabetes monitoring system	Patients recorded information about their meal portions and blood glucose reading in a hand-held electronic diary, and transmitted the data to the diabetes monitoring system through a telephone modem. The patients received immediate feedback about the carbohydrate, protein and fat content of the meal, as well as the calorie content.	10/0
				Usual care	Patients had conventional follow-up consultations with a diabetes team	10/1
Vähätalo, 2004[42];	To assess transmission of glucose values by cellular	12 months	Finland; 1 centre;	Home telemonitoring	Patients were advised to test their plasma glucose and send the results via the phone.	102/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Prospective study	phone in the treatment of type 1 diabetic patients		Sponsor NR; Nokia provided some supplies	(cellular phone-based)	Additional comments and questions could also be sent. Two doctors monitored the results weekly during the first month and thereafter biweekly. The doctors checked all the results and sent back comments to the patients. Patients continued normal visits to their diabetes physician at 3- to 4-month intervals	
				Usual care	Patients continued normal visits to their diabetes physician at 3- to 4-month intervals	101/NR
Wojcicki, 2001[41]; RCT	To present and discuss the therapeutic effectiveness of an intensive care telematic system designed and applied for intensive treatment of pregnant type 1 diabetic women.	3 years	Poland; Centres NR; Government and Industry (Bayer and Polish Cellular Telephony Centertel)	Home telehealth	The telematic management system consisted of a central clinical usual care unit (CCU) and a set of patients' teletransmission modules (PTM). The PTM contained a blood glucose meter with internal memory (capable of storing blood glucose measurements, insulin doses, markers of meals, physical activity, symptoms of hypoglycemia and special events), a standard serial communication port, a standrd modem and a phone set. The data collected from the patients were automatically transformed and stored in a ready-to-use format in the database. The diabetologist examined the data in the morning and made telephone call to the patient to modify the treatment if necessary	17/2
				Usual care	Patients were treated based on clinical examinations performed every 3 weeks	15/0
Wong, 2005[47]; RCT	To compare patient outcomes between usual care group receiving routine inpatient hospital care and a study group	24 weeks	China; 1 centre; Sponsor NR	Nurse telephone monitoring	Patients were discharged early and received a standardized education program prior to discharge. The diabetes nurse specialist made telephone contact with the patients every 1-2 weeks until the glycemic levels were stable.	60/8

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	receiving an early discharge and follow-up program, which included a weekly or biweekly telephone call from a nurse				The nurse arranged for the patient to return to the clinic if physical assessment of face-to-face teaching were deemed necessary. The nurse consulted the physician and changed the treatment plan accordingly.	
				Usual care	Patients remained in the hospital until a stable glycemic level was maintained. They received routine diabetes education during hospitalization	60/11

APPENDIX 4B: STUDY CHARACTERISTICS (HEART FAILURE)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Artinian, 2003[48]; RCT	To compare the effects of self-care and medication compliance device, linked to a Web-based monitoring system, to the effects of usual care alone on compliance with recommended self-care behaviours	3 months	US; 1 centre; Government	Web-based intervention (compliance device) + usual care	In addition to usual care, patients received eMonitor, a device the size of a videocassette which retains a supply of up to 5 medications in each compartment and has an alarm reminder. The device also has other remainders in daily management of the disease. The monitor was connected to a telephone line, and the information was automatically transmitted to the Med-eMonitor server.	9/0
				Usual care	Patients had visits to HF clinic at regular intervals with frequency (weekly to several months) based on the severity of the disease. Pharmacist assessed medication-taking and provided information.	9/0
Barth, 2001[68]; Prospective study	To determine the effect of a structured nurse-managed post-discharge program for congestive heart failure patients	2 months	US; 1 centre; Sponsor NR	Nurse telephone monitoring	Patients received routine teaching at the time of discharge. Nurses contacted patients by telephone at 72 hours post-discharge, 72 hours later, then every 2 weeks for 2 months.	17/NR
				Usual care	Patients received teaching at the time of discharge, then routine care.	17/NR
Benatar, 2003[49]; RCT	To compare HF outcomes for patients whose home health care was provided by nurse telemanagement or home nurse visits	3 months	US; Multiple centres; Government (NIH)	Nurse telemanagement	Patients used transtelephonic home monitoring devices to measure their weight, blood pressure, heart rate, and oxygen saturation level. The data were transmitted daily to a secure internet site. The advanced-practice nurse evaluated the data transmitted, conducted telephone assessments, titrated medication therapy, and conducted patient education as needed to achieve the goal of medical plan developed by the physicians and the nurse.	108/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Home nurse visit	Patients received 3 visits during the first week, 2 visits during the second and third weeks, 1 visit during the fourth and fifth weeks, and further visits on as-needed basis.	108/0
Bondmass, 1999[50]; Pre-post	To determine the effect of physiologic home monitoring and telemanagement on chronic HF outcomes	12 months	US; 1 centre; Sponsor NR	Before trans-telephonic monitoring		60/12
				After trans-telephonic monitoring	Equipment: home monitor attached to an integral scale stand, a data-receiving computer, and a network server connection. Patients measured their weight, blood pressure, heart rate, and oxygen saturation daily. The data were transmitted via the monitor's modem and patients were telemanaged accordingly.	
Capomolla, 2004[51]; RCT	To describe the comprehensive home telemonitoring service (TMS) and to evaluate its outcomes in comparison to the usual program of care after discharge from a HF unit	10 ± 6 (SD) months	Italy; 1 centre; Government	Home telemonitoring service (TMS)	Patients used the touch-pad of their home or mobile phone to send information concerning vital signs and symptoms. Each parameter was entered in reply to a question asked by a recorded voice. Each patient was allowed to contact the medical staff at any time by leaving a message on an answering machine integrated in the interactive voice system. Daily telemonitoring activities were monitored automatically by software to identify and alarm patients who had not transmitted their vital signs or had at least one parameter out of range. These patients were contacted by phone. The nurses prepared printouts of all parameters previously transmitted and submitted these to the physician for analysis. Patient could be contacted for counselling, changing therapy or further examinations.	67/12

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual community care	Patient returned to the community and was followed-up by a primary care physician with the support of a cardiologist. The process of care was governed by different providers who managed the patient's needs with a heterogeneous range of strategies: emergency room management, hospital admission and outpatient access.	66/NR
Cleland, 2005[52]; RCT	To identify whether home telemonitoring improves outcomes compared with nurse telephone support and usual care for patients with HF who are at risk of hospitalization or death	240 days (8 months)	Netherlands, UK, Germany; 16 centres; Government and industry	Home tele-monitoring	Twice-daily patient self-measurement of weight, blood pressure, heart rate and rhythm with automated devices linked to a cardiology centre.	168/5
				Nurse telephone support	Usual care plus specialist nurses, who contacted patients by telephone each month to assess symptoms and current medication.	173/3
				Usual care	Primary care physicians delivered usual care.	85/0
Cordisco, 1999[53]; Prospective study	To investigate whether the application of a daily telemonitoring system that measures weight and records symptoms could decrease hospitalizations and emergency room visits in patients with severe CHF	Approx. 1 year	US; 1 centre; Sponsor NR	Tele-monitoring	Patients were provided a day link monitor, which combined an electronic scale with a display and communication device. The monitor weighed the patient, noted if the patient was above target weight, and asked the patient 5 simple yes/no questions about symptoms. The monitor transmitted the information over the patient's phone line using a toll-free number to a central station where the nurse reviews the data on a daily basis.	30/NR
				Usual care	Patients followed up in the HF program were instructed to weigh themselves daily and to contact the clinic for a weight gain of >5 lbs.	51/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
DeBusk, 2004[69]; RCT	To determine whether a telephone mediated nurse care management program for heart failure reduced the rate of re-hospitalization over a 1-year period	12 months	US; 5 centres; Government	Nurse telephone monitoring	In addition to usual care, patients received a physician-directed, nurse-managed, home based program for heart failure developed by the investigators. The telephone-mediated intervention included initial education session, including video tape, baseline telephone counselling session, nurse-initiated follow-up telephone contacts, pharmacologic management, and nurse-initiated communication with physicians. Calls were weekly for 6 weeks, biweekly for 8 weeks, monthly for 3 months, bimonthly for 6 months, and as needed.	228/29 (including 21 deaths)
				Usual care	NR	234/43 (including 28 deaths)
Dunagan, 2005[70]; RCT	To study the impact of a nurse-administered, telephone-based disease management program on the need for hospital-based care, mortality, functional status, and satisfaction with care	1 year	US; 1 centre; Industry	Telephone monitoring	Usual care plus intervention. The intervention included regularly scheduled telephonic monitoring by specially trained nurses supervised by cardiologists specialized in HF. If there was evidence of an exacerbation, program nurses recommended that patient take supplemental diuretics or contacted the patient's physician for instructions.	76/0
				Usual care	Provided by the primary care physician	75/0
Galbreath, 2004[71]; RCT	To evaluate the effectiveness of disease management (by telephone) as a clinical and cost containment strategy in both systolic and diastolic CHF over a longer time period and	18 months	US; 1 centre; Government	Nurse telephone monitoring	Patients were mailed educational material on CHF and received a bathroom scale. A registered nurse with specialized cardiac training provided patient education and medication management in conjunction with the primary care provider. Initial call frequency was weekly, with a transition to monthly for the duration of the intervention,	710/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	with a larger and more heterogeneous sample than those of previous studies				with frequency adjusted as needed. After each call, a call summary was faxed to the patient's primary care provider.	
				Usual care	Patients were managed as usual by their physicians	359/NR
Gattis, 1999[72]; RCT	To evaluate the effect of a clinical pharmacist on outcomes in outpatients with heart failure	6 months (median)	US; 1 centre; American Society of Health-System Pharmacists Research and Education Foundation, and Duke Clinical Research Institute	Pharmacist telephone monitoring	The clinical pharmacist discussed the patient's case and verbally provided therapeutic recommendations regarding optimization of therapy to the attending physician. The clinical pharmacist provided telephone follow-up at 2, 12, and 24 weeks after the initial visit to identify problems with drug therapy, to answer drug related questions, and to identify the occurrence of clinical events.	90/NR
				Usual care	Patients received usual care from their physicians.	91/NR
GESICA Investigators, 2005[73]; RCT	To determine whether a centralized telephone intervention reduces the incidence of death or admission for worsening heart failure in outpatients with chronic heart failure	16 months (mean)	Argentina; 51 centres; GESICA Foundation and Industry (Roche, Boehringer Ingelheim, Bagó, Pharmacia, Novartis, and Merck Sharp and Dohme)	Nurse telephone intervention	Patients received an education booklet. Nurses trained in the management of patients with heart failure maintained frequent telephone follow-up from the telephone intervention center. The intervention was based on 5 main objectives: adherence to diet, adherence to drug treatment, monitoring of symptoms, usual care signs of hydrosaline retention, and daily physical activity. Nurses recorded data with special software and could adjust the dose of diuretic or recommend non-scheduled medical or emergency visits.	760/14

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care	Patients were followed by their attending cardiologists.	758/3
Giordano, 2008[54]; RCT	To determine whether a home-based telemanagement program in CHF patients decreased hospital readmissions and hospital costs in comparison with the usual care follow-up program over a one-year period	1 year	Italy; 5 centres; Government	Home-based tele-management	Patients received a portable device that transferred by telephone, a one-lead trace to a receiving station where a nurse or doctor was available for interactive teleconsultation. Scheduled telemonitoring appointments were done every week or every 15 days for patients with severe or moderate HF. Occasional tele-assistance appointments were done according to patients' needs.	230/4
				Usual care	Patients were referred to their primary care physicians and cardiologists.	230/1
Goldberg, 2003[55]; RCT	To determine whether daily reporting of weight and symptoms in patients with advanced heart failure would reduce re-hospitalization and mortality rates despite aggressive guideline-driven heart failure care	6 months	US; 16 centres; Industry (Alere Medical)	Home telehealth	Patients received the AlereNet monitoring system using a DayLink monitor. The system includes an electronic scale placed in the patient's home and an individualized symptom response system (DayLink monitor) linked via a usual phone line using a toll-free telephone number to a computerized database monitored by trained cardiac nurses. The AlereNet nurses reviewed the patients' weights and responses on a daily basis and contacted patients as necessary. The nurses reported to the physician for any increase in weight beyond a pre-specified amount.	138/11 deaths (withdrawals NR)
				Usual care	Patients were instructed to use a usual scale for daily weight assessment and to contact their physicians for weight increases or if their symptoms of heart failure worsened.	142/26 deaths (withdrawals NR)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Heidenreich, 1999[74]; Prospective study	To examine the effects of a low-intensity monitoring program on hospitalizations and cost of care for patients with heart failure treated by community physicians	7.4 ± 3 months	US; Multi-centre; Government and Industry (LifeMasters Supported SelfCare)	Telephone monitoring	Patients received a digital scale and an automatic blood pressure cuff. They sent their blood pressure, pulse, weight and any symptoms daily via a telephone line into a computerized voice answering system. If reported values were outside the accepted range, the computer paged a nurse, who would call the patient to confirm the data. Once confirmed, the nurse faxed that data to the physician. Patients could contact their physician directly if they were concerned about their health. Patients received weekly educational mails and a 10-min call from a nurse.	68/NR
				Usual care	NR	86/NR
Jerant, 2003,2001 [56,102]; RCT	To compare 3 post-hospitalization nursing care models for reducing CHF readmission charges	≥60 days	US; 1 centre; Government	Video-based home telecare	Patients received scheduled home telecare visits using an Aviva SL1010 Personal Telecare unit. The unit operated over a usual analog telephone line and allowed real-time videoconferencing with the study nurse at the central monitoring computer at the medical center. There was an integrated stethoscope.	13/0
				Telephone calls	Patients received scheduled phone calls from the study nurse. Intervention was similar to home telecare, but without video and electronic stethoscope.	12/1
				Usual care	Patients received care directly from their primary care provider.	12/0
Krumholz, 2002[75]; RCT	To determine the effect of targeted education and support intervention on the rate of readmission or death and hospital costs in	12 months	US; 1 centre; Sponsor NR	Telephone monitoring	Patients received an in-depth educational session from an experienced cardiac nurse within 2 weeks of hospital discharge. Subsequently, the nurse contacted the patient by phone on a weekly basis for 4 weeks, then	44/9 deaths (withdrawals NR)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	patients with heart failure				biweekly for 8 weeks and then monthly for a total period of one year. The calls reinforced care domains but did not modify regimens or provide treatment recommendations. The nurse could recommend that the patient consult with his or her physician.	
				Usual care	Patients received usual care and services ordered from their physicians	44/13 deaths (withdrawals NR)
LaFramboise, 2003[57]; RCT	To determine the feasibility of providing a HF disease management program through an in-home telehealth communication device (Health Buddy) and to compare the effectiveness of the Health Buddy with traditional home management strategies in achieving selected patient outcomes	2 months	US; Centres NR; Sponsor NR	Health Buddy	Patients received assessment and education through a telehealth communication device called the Health Buddy.	21/NR
				Health Buddy + home visits	Patients received assessment and education through 5 home visits and the Health Buddy.	20/NR
				Telephone	Patients received telephonic case management similar to that provided by nurses who telephonically monitor a large client caseload.	26/NR
				Home visit	Patients received 5 home visits by a research nurse for assessment and education related to HF, an intervention designed to be similar to visits provided by home health nurses.	23/NR
Laramee, 2003[76]; RCT	To test the effect of congestive heart failure case management on the 90-day re-admission rate in a more heterogeneous setting	3 months	US; 1 centre; Government and Industry (Novartis Pharmaceuticals)	Nurse telephone monitoring	The intervention consisted of 4 major components: (1) early discharge planning and coordination of care, (2) individualized and comprehensive patient and family education, (3)12 weeks of enhanced telephone follow-up and surveillance, and (4) promotion of optimal CHF medications and medication doses based on consensus guidelines. Patients received education materials. Patients and/or family members received	141/19 (including 13 deaths)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					telephone calls at 1 to 3 days after discharge and at weeks 1, 2, 3, 4, 6, 8, 10 and 12. Patients were instructed to contact their physician any time a change in symptoms occurred.	
				Usual care	Patients received usual care, typical of a tertiary care hospital, and all conventional treatments requested by the attending physician. Post discharge care was conducted by the patient's own local physician and could include home care services.	146/34 (including 15 deaths)
de Lusignan, 2001[58]; RCT	To examine the acceptability, effectiveness, and reliability of home telemonitoring	3-12 months	UK; 1 centre; Industry	Telemonitoring	Patients had pulse and blood pressure devices, video consultation equipment and scales installed in their homes. Data was transfer via telephone line to a telemonitoring server, where clinicians of the study practice, a cardiologist or a consultant clinical physiologist could view the data. The study nurse reviewed the data every working day. Video consult was given weekly for 3 months, then biweekly for 3 months, then monthly.	10/2
				Usual care	Patients received usual general practice treatment. They had their pulse, blood pressure and weight measured quarterly. They were evaluated in the same way as the intervention group.	10/2
McManus, 2004[59]; Prospective study	To compare the readmission rate of home care patients with a primary diagnosis of CHF receiving telehealth to that of patients receiving a schedule of routine home	30 days	US; 1 centre; Sponsor NR	Telehealth monitoring	A telehealth nurse installed telehealth equipment and gave instructions and a demonstration to patients. The Aviva SL1010 Personal Telecare Unit provided video conference capability, stethoscope, blood pressure cuff, finger pulse oximeter, and optional digital scale.	19/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	care visits			Routine home care	No details provided	41/0
Mehra, 2000[60]; Prospective study	To determine the clinical feasibility of electronic home monitoring for chronic HF patients	3 months	US; 3 centres; Sponsor NR	Electronic home monitoring	Daily monitoring of patients in their homes with the Sentry-Observer system, which combined clinical-grade medical monitoring devices, a single board computer and sound system, and a networked information system. Patients took their own vital signs, and answered yes or no questions. Data was automatically sent via the telephone line to the centre monitored by the physician.	53/NR
				Usual care	Patients unmonitored	60/NR
Myers, 2006 [61]; Prospective study	To assess the effectiveness of home telemonitoring in patients with class 3 or 4 CHF, recently discharged from the hospital	≤ 2 months	US; 1 centre; Sponsor NR	Home tele-monitoring	Telemonitoring equipment included: an NX monitoring station, a LifeSource digital weight scale, an A&D blood pressure/pulse cuff and meter and a BCI pulse oxymetry device. Patients transmitted their vital signs and weight on a daily basis to the telemonitor nurse, who telephoned the patients to discuss the results within an hour of receiving the readings. The nurse also made a weekly home visit.	83/19
				Usual care	Home health care.	83/24
Quinn, 2006[77]; Prospective study	To use low-technology equipment to improve care for patients with HF enrolled in a home health agency	9 weeks	US; 1 centre; Sponsor NR	Low-technology monitoring	Equipment: home blood pressure monitor, digital scale, telephone access, patient notebook/log, teaching tool for the nurse, and a combination of home visits and telephone visits.	17/0
				Usual care	Visits by home healthcare nurses as required.	9/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Riegel, 2002[78]; Cluster RCT	To assess the effectiveness of a standardized telephonic case-management intervention in decreasing resource use in patients with chronic heart failure	6 months	US; 2 centres; Industry (Pfizer)	Nurse telephone monitoring	A registered nurse provided telephonic case management using a decision-support software program developed by Pfizer. Patients were telephoned within 5 days after hospital discharge and thereafter at a frequency guided by the software and case manager judgement based on patients' symptoms, knowledge and needs.	130/NR
				Usual care	Patients received some education regarding HF management prior to hospital discharge and care from their physicians	228/NR
Riegel, 2006[79]; RCT	To test the effectiveness of telephone case management in decreasing hospitalizations and improving health-related quality of life and depression in Hispanics of Mexican origin with HF	6 months	US; 2 centres; American Heart Association	Telephone case management	The emphasis of the intervention was on education, monitoring, and guidance. A software program guided the nurse case manager to assess factors previously shown to predict HF hospitalization and teach patients self-care skills. Automated tools embedded in the software assisted the nurse in setting priorities for the timing of the next telephone call, content of patient education, and documentation. Nurse case managers telephoned physicians as needed and mailed reports on patient progress at regular intervals.	70/1
				Usual care	Patients were educated regarding HF management before hospital discharge, including a medication list and an institution-specific discharge instruction sheet with handwritten notes to follow a low sodium diet and contact the physician if symptoms occurred.	65/0
Roth, 2004[62]; Pre-post study	To assess the effect of a transtelephonic monitoring and follow-up program on the admission	1 year	Israel; 1 centre; Sponsor NR	1 year post tele-cardiology	Monitoring centre managed by intensive care nurses who dispatched mobile intensive care units staffed by physicians and paramedics to patients. Each patient's medical file was	118/23

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	rate and length of hospital stay, as well as changes in their quality of life, of patients with chronic HF				stored in a central computer and updated continuously. All patients carried a cardiobeeper to transmit ECG data via a regular household telephone. After interpreting the data, the nurse either dispatched a mobile intensive care unit to the patient, consulted the physician, or provided patient with established medical or behavioural instructions. Each patient was also equipped with an electronic scale and blood pressure measuring device, connected to the monitoring centre via a telephone line.	
				1 year pre tele-cardiology	No details given	
Schofield, 2005[63]; Pre-post study	To describe the early outcomes of a study before and after enrollment into the HF home-telehealth program, but without randomization or usual cares	6 months	US; 1 centre; Government	Post enrollment in home telehealth program	Patients were provided with a digital scale, a digital blood pressure/heart rate monitor, and an in-home message device (Health Buddy) for reporting daily patient symptoms and vital signs to the nurse care coordinator via a secure internet site. The patient was given daily reminders regarding appropriate HF self-management. Highly symptomatic patients received priority for personal phone calls from nurse care coordinator. The interdisciplinary team met biweekly to discuss patient status and vital signs/symptom reports.	92/19
				Pre enrollment	No details given	
Schwarz, 2008[64]; RCT	To examine whether telemonitoring by an advanced practice nurse reduced subsequent hospital readmissions, emergency department	3 months	US; 1 centre; Government	Home tele-monitoring plus usual care	Patients received a Cardiocom EHM system, which has a weight scale connected via the telephone line to a computer system in the collaborating hospital. Weight was measured on a daily basis. Patients answered yes or no questions about their symptoms, medication	51/7

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	visits, costs, and risk of hospital readmissions for patients with HF				use, and salt intake. When the measurements were outside the prescribed parameters, the monitoring nurse called the caregiver to further assess the situation, provide education and update the medication regime.	
				Usual care	No details given.	51/11
Seibert, 2008[65]; Prospective study	To investigate the effects of a 6-week in-home telemedicine education and monitoring program, for those with systolic dysfunction, on the utilization of health care resources	6 weeks intervention + 4.5 months follow-up (after removal of the unit)	US; Centres NR; Government	Home telehealth	Patients were given a copy of the Learning to Live with Heart Failure Self-Care Handbook. Patients completed a monitoring session each morning for a 6-week period. The session included weighing themselves on a scale and answering a health questionnaire. The telemedicine unit was ViTel Net's DataGate System which included a notebook PC, touch-screen monitor, and a scale. No patient weights or responses to the health questions were sent to the research team. The research team only tracked whether or not the patient interacted with the monitor on a daily basis. If there was a weight gain or loss off the limits, the patient was prompted to contact their physician.	13/NR
				Usual care	Patients were given a copy of the Learning to Live with Heart Failure Self-Care Handbook. No other details of usual care was reported.	10/NR
Shah, 1998[80]; Pre-post study	To determine whether a less intensive program with patient education materials, automated reminders for medication compliance, self-monitoring of daily weights and vital signs, and facilitated telephone	12 months	US; 1 centre; Government	Post enrollment in nurse telephone monitoring program	Patients were mailed educational materials weekly for initial 8 weeks. Patients were given a digital sphygmomanometer, digital weight scale, and an alphanumeric pager. The pager was used to transmit computer-generated reminders to patients to take medications, weigh themselves, and measure their blood pressure and heart rate. The nurse contacted patients once a week by phone.	27/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	communication with a nurse-monitor could reduce hospitalizations and whether this benefit could be extended to younger outpatients				Patients were given 24-hour telephone access to a nurse to report emergencies or changes in their medical conditions.	
Tsuyuki, 2004[81]; RCT	To evaluate the effect of a disease management program on clinical and economic outcomes in patients with HF	6 months	Canada; 10 centres; Industry (Pfizer)	Pharmacist or nurse telephone monitoring	Patients were given heart disease management education from a local research coordinator on a 1-to-1 basis. Patients also received adherence aids: a medical organizer, medication administration schedule, and daily weigh log. The local research coordinator contacted the patients by telephone at 2 weeks, 4 weeks, then monthly for 6 months after discharge. The follow-up focused on 5 essential components: salt and fluid restriction, daily weighing, exercise alternating with rest period, proper medication use, and knowing when to call the physician.	140/24 (including 16 deaths)
				Usual care	Patients received a general heart disease pamphlet before discharge and monthly telephone contact to ascertain health events. Patients received regular care from their physicians.	136/18 (including 12 deaths)
Vaccaro, 2001[66]; Pre-post study	To quantify the impact of the "Taking Charge of Your Heart Health" program on health care utilizations and costs as compared with usual care in patients with chronic HF	6 months	US; 3 centres; Sponsor NR	Home tele-monitoring (prospective)	The Health Hero platform consists of the iCare Desktop and the Health Buddy, which is placed in the patient's home. Patient is provided with in-home daily monitoring (coaching, education, and reinforcement of self-care skills) and timely physician feedback using the Health Buddy. The care managers use the iCare Desktop to review patient responses, analyze patient trends, present reports to physicians, and rapidly identify those patients in need of care.	52/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care (retrospective)	No disease management program provided to patients.	638/NR
Wheeler, 2006[82]; Prospective study	To assess the effectiveness of regular telephone interventions by nursing students on outcomes of HF patients in the home	12-14 weeks	US; 1 centre; Government	Telephone	Home care nurses followed the patients for 1-4 weeks. After the patient was discharged from home care, the student nurse followed him or her for an additional 8-12 weeks. During the calls, students reinforced patients' prior learning about their disease and treatment, encouraged compliance with medications and diet, and identified signs and symptoms of worsening heart failure. Students instructed patients to call their primary caregiver when guidelines indicated this was necessary.	20/NR
				Usual care	Patients received the usual follow-up from home care nurses, but did not receive long-term follow-up from students.	21/NR
Woodend, 2008[67]; RCT	To determine whether telephone monitoring of patients with cardiac disease (HF and angina) at high risk of readmission would reduce hospital readmissions, improve functional status, and improve quality of life over usual care	3 months	Canada; Centres NR; Industry	Telehome monitoring	Home-monitoring equipment was set-up at the patient's home and the patient was trained to use. Intervention consisted of video conferencing with a nurse, and daily transmission of weight and blood pressure, and periodic transmission of 12-lead electrocardiogram, via telephone lines to a central station at the Heart Institute.	62/NR
				Usual care	Patients were discharged to the care of their community physician or cardiologist.	59/NR

HF=heart failure; CHF=congestive heart failure

APPENDIX 4C: STUDY CHARACTERISTICS (COPD)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Bourbeau, 2003[87]; RCT	To evaluate the effect of a continuum of self-management, specific to COPD, on the use of hospital services and health status among patients with moderate to severe COPD	12 months	Canada; 7 centres; Industry (Boehringer Ingelheim Canada)	Telephone monitoring	Weekly telephone call for 8 weeks (educational period), then monthly calls for the remainder of the study. Care managers (nurses, respiratory therapists, and physiotherapists) were available by telephone for advice and treatment supervision throughout the study period. Patients continued to receive usual care from their specialists or general practitioners	96/10
				Usual care	Patients received usual care from their specialists or general practitioners.	95/16
Casas, 2006[88]; RCT	To determine whether a simple and well-standardized, low-intensity integrated care intervention could be effective in preventing hospitalizations of COPD patients	12 months	Spain, Belgium; 2 centres; Government	Integrated care with telephone monitoring	Integrated care consisted of four features: (1) a comprehensive assessment of the patient at discharge, (2) an educational program on self-management of the disease administered at discharge, (3) agreement on an individual tailored care plan following international guidelines, (4) accessibility of the specialized nurse to patients/cares and primary care professionals during the follow-up period. Weekly phone calls during the first month after discharge were carried out to reinforce self-management strategies.	65/17 (including 12 deaths)
				Usual care	Patients received usual care from their physicians	90/18 (including 14 deaths)
de Toledo, 2006[84]; RCT	To study the effects of a telemedicine system for the care of patients with COPD on health outcomes, system's usage patterns, acceptability to	1 year	Spain; Centres NR; Government	Home telehealth	Chronic Care Platform using computer-telephony integration was developed. A Central Patient Management Module was accessible to all care team members from any location. The patient unit included telemonitoring, text messaging, televisits,	67/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	professionals, and costs				and access to educational web material and videos. Patients received a 1.5 hour educational session and one home visit (24 to 72 hours post-discharge), then had telephone access to the call centre.	
				Usual care	Patients received education and home visits as needed, but did not have access to the call centre.	90/NR
Egan, 2002[89]; RCT	To assess the impact of an RCT of nursing-based care management for patients with COPD, their caregivers, and nursing and medical staff	3 months	Australia; 1 centre; Government	Telephone support	The case manager provided education for the patient and caregiver on managing the disease, medications, rehabilitation, and available community services, and arranged discharge planning. The case manager ensured that planned outcomes were achieved through phone calls to the patient and caregiver on a regular basis.	33/5
				Usual care	Patients received normal care, had no contact with case manager, no case conferences, and no post-discharge follow-up.	33/8
Farrero, 2001[90]; RCT	To analyze the influence of a hospital-based home care program on the management of patients with COPD receiving long-term oxygen therapy	12 months	Spain; 1 centre; Sponsor NR	Nurse telephone monitoring	Patients received a monthly telephone call, home visits every 3 months, and home or hospital visits on a demand basis.	60/14
				Usual care	Patients received conventional care, including an initial visit and 1-year visit in the outpatient department.	62/14
Paré, 2006[83]; Quasi-experimental study	To compare the effects and costs of care provided to a group of 19 patients under a telehomecare program to a comparable group of 10 patients receiving regular home care	6 months	Canada; 1 centre; Government	Home telehealth	Patients received training on a Webphone, with an integrated touch screen and modem, programmed with personalized protocol. Data entry forms documenting peak flow rate, symptoms and medication were filled out daily by patient and sent over the internet. Data were analysed by the system and reviewed daily by a nurse. Patients and the nurse were alerted to readings falling outside established parameters.	20/1

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care	Regular home care with no telemonitoring	10/0
Trappenburg, 2008[85]; Prospective study	To determine the effects of a home-based telemonitoring device, the Health Buddy, on health consumption and health-related quality of life in patients with moderate to severe chronic obstructive pulmonary disease	6 months	The Netherlands; 6 centres; Dutch Asthma Foundation	Home telehealth	Patients received care as usual plus telemonitoring, provided by Hero Health Network (Health Buddy device). Patients answered daily questions that monitored their disease symptoms, medication compliance, and knowledge. Device provided education about their condition. Each answer to a question received immediate feedback from the device. Patients' responses were sent via telephone line to Health Hero's secure data centre and automatically categorized and prioritized. Respiratory nurses reviewed patients' answers and provided telemonitoring to the patients. When needed, the pulmonary physician or clinic was notified.	101/42
				Usual care	Patients received usual care.	64/8
Vontetsianos, 2005[86]; Pre-post study	To evaluate the clinical usefulness of an advanced system of e-health services in home-based integrated care for patients suffering mainly from COPD	Pre: 12 months Post: 9 months	Greece; Centres NR; Sponsor NR	Telemedicine-assisted home support	Initial phase: Patients attended 10 3-hour sessions every other day to create electronic health record, for evaluation by each team member, training for self-management identification of exacerbation and anxiety usual care. Chronic phase: Visits to patients' homes either scheduled or emergency visits. The visiting nurse was equipped with a case containing a laptop computer with Frontis software and a number of medical devices, including ECG recorder, spirometer,	18/NR

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
					oximeter, blood pressure monitor, and a videoconference camera for real time audiovisual connection with the hospital using the patient' TV set. A single ISDN line (128 kbit/s) was installed in each house. The nurse monitored vital signs and treatment compliance, and transmitted data to the hospital. The nurse could also communicate with rehabilitation team members.	
				Previous 12 months	NR	
Wong, 2005[91]; RCT	To determine whether a nurse-initiated telephone follow-up program could increase patients' self-efficacy in managing dyspnea, and decrease health care service use	1 and 3 months	China; 1 centre; RCT	Nurse telephone monitoring	A nurse contacted patients twice, on days 3-7 and days 14-20. The nurse was guided by a protocol consisting of 3 parts: assessment, management options, and evaluation.	30/0
				Usual care	Patients received routine care without telephone follow-up.	30/0

APPENDIX 4D: STUDY CHARACTERISTICS (MIXED CHRONIC DISEASES)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
Alkema, 2006[99]; RCT	To evaluate mortality over 24 months for Medicare managed care members who participated in the Care Advocate Program designed to link those with high health care utilization to home- and community-based services	24 months	US; 4 centres; Government	Telephonic social care management	Telephone-based management for older adults with high health care utilization enrolled in a Medicare managed health plan. Patients received a call within 1 week of assessment, then monthly follow-up calls to monitor progress, offer support and coaching, and provide additional information.	377/92
				Usual care	NR	404/68
Chumbler, 2004[92]; Case-usual care study	To compare health-related outcomes, during a 1-year period, for 2 groups of frail elders – one receiving care coordination via distance monitoring (home-telehealth) and one receiving no intervention	12 months	US; Multi-centres; Government	Home telehealth	Patients were given one of 3 forms of distance monitoring technology – 1) hand-held in-home messaging device with disease management dialogues (Health Buddy); 2) telemonitor from American Telecare with 2-way audio-video connectivity that also allowed for biometric monitoring of blood pressure, heart rate, weight, oxygen saturation, and heart and lung sounds; 3) videophone with two-way audio-video connectivity (Wind Currents TeleVyou 500) without biometric monitoring. All equipment communicated through usual analog phone lines. The care coordinators monitored the health status of patients on a daily basis for the hand-held messaging group (average 30 min interactive sessions), and assessed on weekly basis for the telemonitor and video phone groups (average 15-20 minutes).	111/0

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual care	NR	115/0
Dang, 2006[93]; Pre-post study	To evaluate in a demonstration project whether the T-Care Program, telecare management via an Internet-based home-messaging device, reduces resource utilization by patients with congestive heart failure, diabetes and COPD	6 months	US; Centres NR; Government	Post telecare management	Patients had daily interactive communication with care coordinator via a computerized, internet-based, in-home messaging/monitoring device (Health Buddy), operating over a usual telephone line. The system included the Health Buddy device, a central data center, and an internet-based service that allowed care coordinators to access the data from remote sites. The care coordinators monitored the system 5 days per week, contacting patients with high risk responses to evaluate symptoms and assess for changes in medical, functional or psychosocial status.	59/NR
				Pre telecare management	NR	
Finkelstein, 2006[94]; RCT	To identify and document the benefits of a telemedicine application compared to usual care for homebound patients receiving home health services after an acute hospitalization for a long-term condition	Up to 6 months	US; 4 centres; Government and Industry (industry not specified)	Video-conferencing and monitoring plus home visits	Home visits by nurse plus 2 virtual visits per week using videoconferencing technology, with some patients also receiving physiologic monitoring for the underlying chronic condition. Equipment was connected to the patient's telephone line and television set. Additional equipment could include automatic blood pressure cuffs, pulse oximeters, and electronic spirometers.	34 completed study (number assigned unclear)

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
				Usual home care	Home visits by nurse as determined by patient's underlying condition	19 completed study (number assigned unclear)
Hopp, 2006[95]; RCT	To determine whether adding telehealth technology to traditional home care services increases health-related quality of life and home care satisfaction, and decreases resource utilization among home care patients	6 months	US; 1 centre; Government	Home telehealth	Patients, in addition to receiving traditional home care services, had contact with the home care staff using telehealth unit (Aviva 1010 video monitor). The unit, connected through a regular telephone line, consisted of a home unit with interactive voice and video technology, and a video camera. Peripheral attachments included blood pressure monitor, stethoscope, and glucose meter.	18/0
				Usual care	Patients received nursing services at home and periodic telephone contact with the clinical staff concerning their home care services	19/0
Johnston, 2000[96]; RCT	To evaluate the use of remote video technology in the home health care setting as well as the quality, use, patient satisfaction, and cost savings from this technology	18 months	US; 1 centre; Sponsor NR	Tele-home health	Patients received video visits in addition to in-person and telephone visits. Video equipment (American Telecare PTS 100) gave patients access to a home health nurse 24 hours a day. After normal working hours, patients had access to the on-call home health nurse by having the Home Health Department contact the patient using the remote video equipment	102/NR
				Usual care	Routine home health care (in-person and phone visits)	110/NR
Kobb, 2003[97]; Quasi-experimental study	To evaluate the use of home telehealth devices to monitor and educate patients to prevent health	12 months	US; Multi-centres; Government	Home telehealth	Equipment included in-home messaging device (Health Buddy), the Aviva 1010SLX with peripheral vital sign monitoring, a telephone and a videophone; all used regular	425 enrolled; 281 used for data.

First author, Year; Design	Objective	Length of follow-up	Countries; Number of centres; Sponsor	Comparison arms	Description of intervention and comparator	Number of patients assigned / withdrew
	crises				analog telephone service. No details given of intervention procedure.	Withdrawals NR
				Usual care	NR	1120/NR
Noel, 2004[98]; RCT	To determine whether home telehealth, when integrated with the health facility's electronic medical record system, reduces healthcare costs and improves quality-of-life outcomes relative to usual home healthcare services for elderly resource users with complex co-morbidities	6 months	US; 1 centre; Government	Home telehealth	Home telehealth plus nurse case management. The home-based telehealth units transferred vital sign data and answers to quizzes from patient's home to central station. Peripheral devices consisted of units measuring temperature, blood pressure, pulse, ECG, heart and lung sounds, pulse oximetry and weight. Out-of-range patient data triggered alerts via the Web to nurse case managers. A digital camera was used to monitor wound care.	47/0
				Usual care	Usual home healthcare services plus nurse case management	57/0

APPENDIX 5A: PATIENT BASELINE CHARACTERISTICS (DIABETES)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
Barnett, 2006[22]	*Inclusion:* ≥ 2 VA (Type 2) hospitalizations or ≥ 2 VA ED visits in previous 12 months *Exclusion:* NR	Home telehealth	391 (NR)	68.1	NR	NR	NR	NR	NR
		Not in program	391 (NR)	67.4	NR	NR	NR	NR	NR
Biermann, 2002[23]	*Inclusion:* Diabetes patients on intensified insulin therapy (≥4 insulin injections daily) (Type 1?) *Exclusion:* NR	Home tele-monitoring	27 (NR)	30.5 ± 11	NR	10.9	8.3 ± 2.3	NR	NR
		Usual care	16 (NR)	30 ± 8.6	NR	8.1	8.0 ± 2.1	NR	NR
Bujnowska-Fedak, 2006[24]	*Inclusion:* Insulin-dependent or non-insulin-dependent (Type 1 and 2) *Exclusion:* NR	Both arms	NR	NR	NR	NR	NR	NR	NR
Chase, 2003[25]	*Inclusion:* Type 1 diabetes for ≥ 1 year, aged 15-20 years, HbA1c 7.0-13.0%, hematocrit 20-55% *Exclusion:* Other significant diseases, use of illegal drugs, planned surgery, intending to become pregnant in next 6 months	Modem transmission review and telephone follow-up	30 (14/16)	17.4 ± 1.7	NR	8.4 ± 4.6	9.0 ± 1.2	NR	NR
		Usual care	33 (16/17)	17.2 ± 1.5	NR	7.4 ± 3.1	8.9 ± 1.1	NR	NR
Chumbler, 2005[26]	*Inclusion:* Veterans with diabetes (NR, but likely type 2) and ≥ 2 hospitalizations or emergency room visits in preceding year	Both arms	445 (439/6)	68.4 ± 9.4	Less than high school: 62% High school & beyond: 38%	NR	NR	NR	NR
Dang, 2007[27]	*Inclusion:* Veterans with diabetes mellitus (Type 2), ≥ 60 years old, resident in Dade or Broward	Both arms	41 (NR)	72 ± 6	NR	NR	7.6 ± 1.8	NR	31

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
	county, primary health care provider at Miami VAMC, home telephone *Exclusion:* Nursing home resident or at imminent risk for nursing home placement, terminal illness, unable or unwilling to answer questions on videophone or telephone								
Harno, 2006[28]	*Inclusion:* Type 1 or 2 diabetes mellitus *Exclusion:* NR	Home telehealth	101 (NR)	NR	NR	NR	7.82 ± 0.13	28.5 ± 0.6	NR
		Usual care	74 (NR)	NR	NR	NR	8.21 ± 0.18 ($p<0.05$)	27.8 ± 0.6	NR
Jansa, 2006[29]	*Inclusion:* Type 1 diabetes for ≥ 2 years and treated with ≥ 3 doses of insulin/day, age 18-50 years, HbA1c ≥ 8% *Exclusion:* Patients beginning continuous subcutaneous insulin infusion, planning to become pregnant or pregnancy, psychiatric disorders, lacking appointment compliance	Home telecare	19 (10/9)	27 ± 11	NR	12 ± 6	8.4 ± 1.2	23.3 ± 2.6	NR
		Conventional	16 (11/5)	23 ± 5	NR	10 ± 6	8.9 ± 1.3	23.5 ± 2.5	NR
Kim, 2003[43]	*Inclusion:* Type 2 diabetes mellitus; ability to perform blood glucose self-testing and insulin self-injection; ability to understand the goal, methods and procedures of treatment	Telephone intervention	20 (7/13)	59.7 ± 7.3	Less than high school: 40% High school and beyond: 60%	14.0 ± 8.9	8.8 ± 1.2	24.6 ± 2.8	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
	Exclusion: HbA1c < 7%, mental illness, severe cardiovascular disease or unusual careled hypertension	Routine care	16 (4/12)	60.9 ± 5.8	Less than high school; 62% High school and beyond: 38%	13.4 ± 7.7	8.2 ± 0.8	24.6 ± 2.8	NR
Kim, 2005[30]	*Inclusion:* Type 2 diabetes mellitus, ability to perform blood glucose self-testing and insulin self-injection, ability to access the web site for inputting blood glucose levels, own cellular phone *Exclusion:* Clinical history of important illness, renal insufficiency, use of insulin pump, or receipt of information for diabetes care from the web site www.dang119.com	Both arms	42 (20/22)	41.5 ± 12.3	NR	4.6 ± 5.3	8.0 ± 2.3	24.3 ± 3.5	NR
Kwon, 2004[31]	*Inclusion:* Type 2 diabetes for ≥ 1 year , ≥ 30 years of age, internet access at home *Exclusion:* Other significant disease that would be likely to affect the outcome and compliance, use of insulin pump	Internet-based blood glucose monitoring system	50 (35/16)	53.5 ± 8.8	NR	7.0 ± 6.3	7.59 ±1.43	24.4 ± 3.4	NR
		Usual care	51 (32/18)	54.7 ± 9.4	NR	6.6 ± 5.7	7.19 ±1.17	23.9 ± 3.1	NR
Ladyzynski, 2007[32]	*Inclusion:* Pregnancy and type 1 diabetes *Exclusion:* NR	Both arms	30 (0/30)	NR	NR	NR	NR	NR	NR
Larizza, 2006[33]	*Inclusion:* Diabetes *Exclusion:* Severe disease that could affect the reliable assessment of the clinical parameters	Home telehealth	30 (NR)	NR	NR	NR	8.46 ± 1.81	NR	NR
		Usual care	26 (NR)	NR	NR	NR	9.56 ± 2.40	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
Liesenfeld, 2000[34]	*Inclusion:* Type 1 diabetes mellitus, age < 26 years old, interest in a telecare program that would last for several months; caretaker required for small children *Exclusion:* NR	Both arms	61 (36/25)	13.3 (range 2 to 25)	NR	5.5 (range 0.5 to 24)	NR	Range 11.2 to 29	NR
Maljanian, 2005[44]	*Inclusion:* Adults with type 1 or 2 diabetes *Exclusion:* Inability to complete survey in English or Spanish, lack of telephone	Telephone monitoring	176 (77/99)	56.98 ± 12.07	NR	101 patients diagnosed within last year	NR	33.32 ± 7.3	NR
		Usual care	160 (80/80)	59.17 ± 13.38	NR	104 patients diagnosed within last year	NR	31.3 ± 5.88	NR
McMahon, 2005[35]	*Inclusion:* Type 2 diabetes, > 18 years old, HbA1c ≥ 9%, ability to understand written and spoken English, willingness to use computer, glucose device and blood pressure monitoring device *Exclusion:* NR	Web-based care management	52 (51/1)	64 ± 7	College or above:59% Below high school: 6%	12.4	10.0 ± 0.8	32.3 ±5.6	NR
		Usual care	52 (52/0)	63 ± 7	College or above:67% Below high school: 2%	12.2	9.9 ± 0.8	34.1 ± 7.0	NR
Warren, 2000[36]	*Inclusion:* Type 2 diabetes, HbA1c > 8%, age > 18 years *Exclusion:* Inability to use equipment, pending surgery, documented psychiatric history	Home telehealth	15 (6/9)	61.5 (range 41 to 73)	NR	NR	9.5 (range 8.1 to 12.6)	NR	NR
		Usual care (usual care)	13 (5/8)	59 (range 32 to 75)	NR	NR	95 (range 8.1 to 11.9)	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
Meneghini, 1998[37]	*Inclusion:* Type 1 or 2 diabetes, requiring increased intervention *Exclusion:* NR	Both arms	107 (NR)	NR	NR	NR	9.8	NR	NR
Piette, 2000[45]	*Inclusion:* Diabetes or prescribed hypoglycemic agent *Exclusion:* Age >75 years; diagnosed psychotic disorder, disabling sensory impairment, life expectancy of <12 months, ability to usual care glucose levels without medication, diagnosed with diabetes in the prior 6 months, planning to discontinued receiving services, primary language neither English nor Spanish, or no access to a push-button telephone.	Automated telephone disease management	127 (49/78)	55.7 ± 10.2	NR	NR	8.8 ± 1.8	34.0 ±9.1	NR
		Usual care	121 (53/68)	53.3 ± 10.5	NR	NR	8.6 ± 1.8	33.4 ±8.1	NR
Piette, 2001[38]	*Inclusion:* Veterans with diabetes, age ≤ 75 years of age, *Exclusion:* Diabetes diagnoses in prior 6 months, diagnosed psychotic disorder, disabling sensory impairment, life expectancy < 12 months, ability to usual care diabetes without medication, intention to discontinue receiving services from the clinic within the 12 month study period, primary language not English or Spanish, touch-tone telephone not available.	Automated telephone disease management	132 (126/6)	60 ± 10	NR	NR	8.2 ± 1.7	31 ± 7	NR
		Usual care	140 (138/2)	61 ± 10	NR	NR	8.1 ± 1.7	31 ± 6	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
Shea, 2006[39]	*Inclusion:* Diabetes mellitus, ≥ 55 years of age, oral fluency in English or Spanish *Exclusion:* Moderate or severe cognitive, visual or physical impairment, presence of severe comorbid disease	Home telehealth	844 (308/ 536)	71 (both arms)	≥ 13 years: 16.1%	NR	7.36 ± 1.48	32.1 ± 6.78	NR
		Usual care	821 (311/ 510)	71 (both arms)	≥ 13 years: 17.5%	NR	7.40 ± 1.60	31.7 ± 6.85	NR
Thompson, 1999[46]	*Inclusion:* Diabetics receiving insulin, previous usual diabetes education, ability to monitor blood glucose level at home, receiving care by an endocrinologist at diabetes centre, recent HbA1c ≥ 8.5% *Exclusion:* Inability to communicate regularly by phone, contraindication to tight glucose usual care, another serious illness, use of insulin pump	Telephone contact	23 (12/11)	50 ± 14.8	NR	19.2 ± 7.9	9.6 ± 1.0	NR	NR
		Usual care	23 (10/13)	47.5 ± 11.8	NR	14.7 ± 9.2	9.4 ± 0.8	NR	NR
Tsang, 2001[40]	*Inclusion:* NR *Exclusion:* NR	Hand-held monitoring system followed by usual care	10 (5/5)	30 ± 8	NR	5.3 ± 6.5	8.56 ± 1.79	22.2 ± 3.1	NR
		Usual care followed by hand-held monitoring system	9 (7/2)	35 ± 8	NR	11.8 ± 3.5	8.81 ± 1.79	26.0 ± 5.8	NR
Vähätalo, 2004[42]	*Inclusion:* Type 1 diabetes *Exclusion:* NR	Home telemonitoring (cellular phone-based)	102 (59/43)	42.8 ± 11.4	NR	NR	7.7 ± 1.3	NR	NR
		Usual care	101	43.1 ±	NR	NR	7.9 ±	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level	Duration of disease (years); mean ± SD	HbA1c (%); mean ± SD	BMI (kg/m^2); mean ± SD	Number of admissions in previous year
			(54/47)	13.6			1.5		
Wojcicki, 2001[41]	*Inclusion:* Type 1 diabetes, duration of pregnancy < 16 weeks, no other diseases, acceptable intelligence level, HbA1c < 9.5% *Exclusion:* NR	Home telehealth	15 (0/15)	25.3 ± 4.1	NR	8.9 ± 5.3	7.96 ± 1.1	NR	NR
		Usual care	15 (0/15)	26.8 ± 4.8	NR	8.7 ± 4.8	8.1 ± 1.7	NR	NR
Wong FKY, 2005[47]	*Inclusion:* Type 1 or 2 diabetes, > 18 years of age, stable general medical condition *Exclusion:* Diabetic ketoacidosis, acute complication, mental illness or poor cognitive state	Nurse telephone monitoring	52 (32/20)	61.3 ± 11.0	Illiterate: 15 (28.8%) Secondary or above: 14 (26.9%)	9.9 ± 7.5	11.2 ± 2.7	24.5 ± 3.9	NR
		Usual care	49 (25/24)	63.7 ± 11.1	Illiterate: 8 (16.3%) Secondary or above: 13 (26.5%)	8.8 ±8.2	10.6 ± 3.2	23.8 ± 3.5	NR

APPENDIX 5B: PATIENT BASELINE CHARACTERISTICS (HEART FAILURE)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
Artinian, 2003[48]	*Inclusion*: Outpatient age ≥18 years, symptomatic left ventricular dysfunction, ejection fraction ≤40%, ownership or rental of a home or apartment with a telephone, ability to read and understand English, plans to remain in the city during the study period *Exclusion*: History of dementia, mental illness, symptomatic infectious disease or advanced liver disease, self-reported substance abuse, hemodialysis, coronary angioplasty within the last 60 days or coronary artery bypass graft surgery within the last 90 days, inability to participate in a 6-minute walk test, terminal stage cancer	Web-based intervention (compliance device) + usual care; Usual care	18 (17/1)	68 ± 11	Mean: 13 years (range, 8-19)	NR	Class 2: 38.9%; Class 3 50%; Class 4 11.1%	NR
Barth, 2001[68]	*Inclusion:* Discharge from an acute care setting with the diagnosis of CHF *Exclusion:* Patients not oriented to time, person, or place, or discharge to an institutional setting	Nurse telephone monitoring	17 (10/7)	78 ± 6.94	Primary: 4 (24%) Secondary: 11 (65%) Post secondary: 2 (12%)	NR	NR	8 (48%)
		Usual care	17 (6/11)	72.41 ± 9.95	Primary: 2 (12%) Secondary: 10 (59%) Post secondary: 3 (18%) Additional: 2 (12%)	NR	NR	5 (30%)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
Benatar, 2003[49]	*Inclusion*: Patients with at least one of the following: (1) documented diagnosis of HF; (2) NYHA functional classification 3 or 4; (3) conventional HF symptoms of dyspnea and edema; (4) ECG evidence suggestive of HF *Exclusion*: Unstable angina, renal failure, severe dementia or another debilitating psychiatric disorder, end-stage HF requiring regular inotropic infusions, anticipated survival of less than 6 months, planned discharge to a long-term care facility, current use of illicit drugs, participation in another HF research protocol within the past 6 months, and/or lack of operational home telephone line	Nurse tele-management	108 (39/69)	62.9 ± 13.2	NR	38.05 ± 13.70	Mean 3.13 ± 0.27(SD)	NR
		Home nurse visit	108 (41/67)	63.2 ± 12.6	NR	38.83 ± 13.97	Mean 3.12 ± 0.25 (SD)	NR
Bondmass, 1999[50]	*Inclusion:* Patients with at least one of the following: (1) documented diagnosis of HF; (2) NYHA functional classification 3 or 4; (3) conventional HF symptoms of dyspnea and edema; (4) ECG evidence suggestive of HF *Exclusion:* Unstable angina, renal failure, severe dementia or another debilitating psychiatric disorder, end-stage HF requiring regular inotropic infusions, anticipated survival of less than 6 months, planned discharge to a long-term care facility, current use of illicit drugs, participation in another HF research protocol within the past 6 months, and/or lack of operational home telephone line	Before trans-telephonic monitoring; After trans-telephonic monitoring	60 (20/40)	61 ± 13	6% completed elementary school; 86% high school and beyond; 8% did not respond	33 ± 12.82	Mean 3.2 ± 0.5 (SD)	NR
Capomolla, 2004[51]	*Inclusion*: Patients with CHF *Exclusion:* Patients with unstable angina, atrial fibrillation, a pacemaker or automatic defibrillator, renal failure, end-stage heart failure requiring intravenous support, planned discharge to an outpatient CHF care facility, and those with very low probability of survival	Home tele-monitoring service (TMS)	67 (62/5)	57 ± 10	NR	29 ± 8	Class 2: 67%; Class 3-4: 33%	NR
		Usual community care	66 (55/11)	57 ± 10	NR	28 ± 7	Class 2: 67%; Class 3-4: 33%	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
Cleland, 2005[52]	*Inclusion:* Patients had hospital admission for or diagnosis of HF within the last 6 weeks *Exclusion:* Patients <18 years of age, unable to comply with home telemonitoring, or awaiting revascularization, cardiac resynchronization or heart transplantation	Home tele-monitoring	168 (134/ 34)	67 ± 13	NR	25 ± 8	Class 1: 22% Class 2: 46% Class 3: 23% Class 4: 8%	NR
		Nurse telephone support	173 (125/ 48)	67 ± 11	NR	25 ± 8	Class 1: 18% Class 2: 44% Class 3: 30% Class 4: 9%	NR
		Usual care	85 (70/15)	68 ± 10	NR	24 ± 8	Class 1: 18% Class 2: 36% Class 3: 42% Class 4: 4%	NR
Cordisco, 1999[53]	*Inclusion:* Patients with severe CHF *Exclusion:* Patients refusing the use of telemonitoring system or waiting for cardiac transplant	Tele-monitoring	30 (21/9)	52 ± 8	NR	20 ± 7	NR	NR
		Usual care	51 (40/11)	54 ± 8	NR	21 ± 7	NR	NR
DeBusk, 2004[69]	*Inclusion:* Hospitalization with a provisional diagnosis of heart failure from Kaiser Permanente medical centres *Exclusion:* Patients scheduled for heart surgery or had undergone heart surgery in preceding 8 weeks, end-stage kidney failure, severe pulmonary disease, expected life	Nurse telephone monitoring	228 (109 /119)	72 ± 11 (both arms)	High school or less: 81 (36%) Beyond high school:	NR	Class 1-2: 50% Class 3-4: 50%	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
	expectancy <1 year, cognitive deficits or psychiatric disorders, substance abuse, expected to move from area within 1 year				123 (54%)			
		Usual care	234 (127/ 107)	72 ± 11 (both arms)	High school or less: 75 (32%) Beyond high school: 144 (62%)	NR	Class 1-2: 50% Class 3-4: 50%	NR
Dunagan, 2005[70]	*Inclusion:* ≥21 years of age, at least one sign and one symptom of heart failure exacerbation, evidence of left ventricular systolic or diastolic dysfunction, NYHA class II, II or IV *Exclusion:* Chronic lung disease, significant aortic stenosis, chronic renal failure, severe comorbidity with anticipated survival of < 6 months, bypass surgery during index admission, heart transplant candidacy, pregnancy, enrollment in another treatment protocol, unable to hear or understand English over the phone, cognitive or psychological impairment precluding effective telephonic monitoring, discharged to a long-term care facility, or no reliable home address	Telephone monitoring	76 (31/45)	70.5 ± 12.7	NR	TotalNR	Class 2: 22% Class 3: 71% Class 4: 7%	NR
		Usual care	75 (35/40)	69.4 ± 13.9	NR	Total NR	Class 2: 17% Class 3: 72% Class 4: 11%	NR
Galbreath, 2004[71]	*Inclusion:* CHF signs and symptoms (as per screening questionnaire) *Exclusion:* NR	Nurse telephone monitoring	710 (504/ 206)	71.0 ± 10.4	NR	NR	Class 1: 18% Class 2: 58% Class 3: 21% Class 4:	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
							3%	
		Usual care	359 (258/ 101)	70.8 ± 9.9	NR	NR	Class 1: 21% Class 2: 55% Class 3: 22% Class 4: 2%	NR
Gattis, 1999[72]	*Inclusion:* LVEF < 45% *Exclusion:* Expected survival < 6 months due to terminal illness, participation in an investigational drug trial at time of study, resident of nursing home, marked dementia or other psychological disorder	Pharmacist telephone monitoring	90 (62/28)	71.5	NR	30	Class 1: 12 (13%) Class 2: 47 (52%) Class 3: 28 (31%) Class 4: 3 (3%)	NR
		Usual care	91 (61/30)	63.0	NR	30	Class 1: 11 (12%) Class 2: 51 (56%) Class 3: 26 (29%) Class 4: 3 (3%)	NR
GESICA Investigators, 2005[73]	*Inclusion:* Diagnosis of heart failure at least 3 months prior to study, stable in ambulatory care (no admissions in previous 2 months, no need for > 1 clinic visit per month, optimal HF treatment not modified in past 2 months), ≥ 18 years of age	Nurse telephone intervention	760 (552/ 208)	64.8 ± 13.9	NR	NR	Class 3-4: 50%	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
	Exclusion: Not contactable by telephone, other cardiac complications, awaiting cardiac transplantation, stroke in last 3 months, pregnancy or not using effective contraceptive methods, alcohol or drug abuse, severe disability, chronic hospitalization, inclusion in another trial within 30 days	Usual care	758 (522/ 236)	65.2 ± 12.7	NR	NR	Class 3-4: 48.8%	NR
Giordano, 2008[54]	*Inclusion:* Patients hospitalized with confirmed diagnosis of CHF, LVEF <40%, at least one hospitalization for acute HF in the previous year, and clinically stable with oral therapy *Exclusion:* Patients had non-cardiac debilitating illness such as active malignancy, severe renal insufficiency, cognitive impairment, myocardial infarction or revascularization procedure within the preceding 30 days, planned coronary revascularization or vascular surgery or heart transplant	Home-based tele-management	230 (193/ 37)	58 ± 10	NR	28 ± 7	Class 2: 54% Class 3-4: 46%	NR
		Usual care	230 (198/ 32)	56 ± 10	NR	26 ± 8	Class 2: 65% Class 3-4: 35%	NR
Goldberg, 2003[55]	*Inclusion:* Patients hospitalized with NYHA class 3 or 4, LVEF ≤ 35%, weight < 400 lbs, ability to stand for at least 20 seconds without holding the wall, speak either English or Spanish *Exclusion:* Unstable coronary syndromes, primary valvular heart disease, primary myocardial disease, pericardial disease, uncorrected thyroid disease, advanced renal disease, requirement for chronic inotropic therapy, heart transplant, anticipated survival < 6 months, no home phone line.	Home telehealth	138 (96/42)	57.9 ± 15.7	NR	21.6 ± 6.8	Class 3: 100 (75.8%) Class 4: 32 (24.2%)	NR
		Usual care	142 (93/49)	60.2 ± 14.9	NR	21.8 ± 6.8	Class 3: 106 (75.2%) Class 4: 35 (24.8%)	NR
Heidenreich, 1999[74]	*Inclusion:* NYHA class II or III *Exclusion:* NR	Telephone monitoring	68 (40/28)	73 ± 13	NR	NR	NR	2.4 ± 3.3 (8.6 ± 19 days)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
		Usual care	86 (50/36)	75 ± 11	NR	NR	NR	1.8 ± 3.3 (8.9 ± 21 days)
Jerant, 2003,2001 [56,102]	*Inclusion:* HF, >40 years old, active telephone line in home, English-speaking, had a family physician or general internist primary care provider, and vision and hearing adequate to utilize telephone or telecare equipment *Exclusion:* Comorbidity score of ≥6, Geriatric Depression Scale score of ≥7, Mini-Mental State Exam score ≤20, or Symbol Digits Modalities Test score ≥2 standard deviations below age- and education-adjusted mean scores	Video-based home telecare	13 (6/7)	66.6 ± 10.9	NR	NR	Class 2: 69% Class 3-4: 31%	NR
		Telephone calls	12 (5/7)	71.3 ± 14.1	NR	NR	Class 2: 67% Class 3-4: 33%	NR
		Usual care	12 (6/6)	72.7 ± 11.4	NR	NR	Class 2: 58% Class 3-4: 42%	NR
Krumholz, 2002 [75]	*Inclusion:* Hospitalization with diagnosis of heart failure; ≥ 50 years of age *Exclusion:* Transfer from another hospital, admission from a nursing home, heart failure secondary to high-output state or non-cardiac diseases, terminal illness	Telephone monitoring	44 (21/23)	75.9 ± 8.7	NR	NR	NR	NR
		Usual care	44 (29/15)	71.6 ± 10.3	NR	NR	NR	NR
LaFramboise, 2003 [57]	*Inclusion:* No visual impairment, ability to speak and read English, and having an active phone service *Exclusion:* NR	Health Buddy	21 (12/9)	66.5 (range 39-91)	11.9 (range 6-18)	NR	NR	NR
		Health Buddy + home visits	20 (11/9)	74.4 (56-90)	11.9 (8-16)	NR	NR	NR
		Telephone	26 (15/11)	67.6 (41-86)	11.4 (7-14)	NR	NR	NR
		Home visit	23 (7/16)	73.4 (53-85)	10.6 (3-16)	NR	NR	NR
Laramee, 2003 [76]	*Inclusion:* Hospitalization with clinical signs and symptoms of CHF, either moderate-to-severe left ventricular dysfunction or radiographic evidence of pulmonary congestion and symptomatic improvement	Nurse telephone monitoring	141 (82/59)	70.6 ± 11.4	Non-high school graduate: 54 (39%)	NR	Class 1: 10 (7%) Class 2: 76 (55%) Class 3:	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
	following diuresis, at risk for early readmission *Exclusion:* Discharge to a long term care facility, planned cardiac surgery, cognitive impairment, anticipated survival < 3 months, long-term hemodialysis						50 (36%) Class 4: 3 (2%)	
		Usual care	146 (74/72)	70.8 ± 12.2	Non-high school graduate: 59 (41%)	NR	Class 1: 35 (26%) Class 2: 47 (36%) Class 3: 46 (35%) Class 4: 4 (3%)	NR
de Lusignan, 2001[58]	*Inclusion:* HF *Exclusion:* Terminal diagnosis, dementia or confusion	Both arms	NR	75.2 (average)	NR	NR	NR	NR
McManus, 2004[59]	*Inclusion:* CHF, ability to sit in front of the patient station for the visit, speak English or have an interpreter at each contact, adequate cognitive ability to interact with the telehealth nurse, and have a primary caregiver if physically unable to perform required tasks *Exclusion:* NR	Both arms	NR	NR	NR	NR	NR	NR
Mehra, 2000[60]	*Inclusion:* CHF *Exclusion:* NR	Both arms	NR	NR	NR	NR	NR	NR
Myers, 2006 [61]	*Inclusion:* CHF patients of class 3 or 4, >64 years old, English speaking, cognitive ability to learn new material, no more than 3 associated comorbidities, a working telephone, and a medicare fee plan *Exclusion:* NR	Home tele-monitoring	83 (38/45)	79.0 ± 6.9	NR	NR	Class 3-4: 100%	NR
		Usual care	83 (35/48)	85.5 ± 5.9, p=0.0005	NR	NR	Class 3-4: 100%	NR
Quinn, 2006[77]	*Inclusion:* HF as primary diagnosis, able to speak and read English, not enrolled in cardiac rehabilitation program, and working telephone	Low-technology monitoring	17 (9/8)	76.53 (range, 49-88)	NR	NR	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
	line *Exclusion:* HF as secondary diagnosis, end-stage HF, and HF symptoms maintained with an intravenous inotropic infusion	Usual care	5 (2/3)	76.2 (range, 66-90)	NR	NR	NR	NR
Riegel, 2002[78]	*Inclusion:* Confirmed clinical diagnosis of HF as primary reason for hospitalization, ability to speak English or Spanish *Exclusion:* Cognitive impairment or psychiatric illness, severe renal failure requiring dialysis, terminal disease, discharge to a long-term care facility, previous enrollment in an HF disease management program	Nurse telephone monitoring	130 (70/60)	72.52 ± 13.05	NR	NR	NR	NR
		Usual care	228 (105/ 123)	74.63 ± 12	NR	NR	NR	NR
Riegel, 2006[79]	*Inclusion:* Patients hospitalized with primary or secondary diagnosis of HF, living in the community and planning to return to the community after hospital discharge *Exclusion:* History of cognitive impairment, severe renal insufficiency requiring dialysis, acute myocardial infarction, a complicating serious or terminal condition such as psychosis or HIV-AIDS, a major and uncorrected hearing loss, lack of access to a telephone, or failure to give informed consent	Telephone case management	69 (29/40)	71.6 ± 10.8	20.3% high school or above	NR	Class 2: 17.4% Class 3: 44.9% Class 4: 37.7%	NR
		Usual care	65 (33/32)	72.7 ± 11.2	23.1% high school or above	NR	Class 2: 20.0% Class 3: 47.7% Class 4: 32.3%	NR
Roth, 2004[62]	*Inclusion:* CHF class 2-4, mental and physical capability, at least 2 documented hospitalizations for exacerbation or worsening of HF during the preceding year, ≤ 90 years old, had functional telephone line *Exclusion:* Refused consent, unstable clinical condition, acute myocardial infarction, end-stage renal failure/dialysis or significant comorbid conditions, or planned cardiac surgery	Both arms (pre-post study)	118 (82/36)	74 ± 9	NR	24 ± 7	Class 2: 22% Class 3: 39% Class 4: 39%	1623

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
Schofield, 2005[63]	*Inclusion:* NYHA class 2-4, active enrollment with a primary care clinic, > 18 years old, working telephone line, capable of self-management for self-monitoring and handling the telehome care *Exclusion:* History of noncompliance, or active substance abuse	Both arms (pre-post study)	92 (91/1)	67 ± 10.5	NR	23 ± 6.9	Class 2: 42% Class 3: 47% Class 4: 10%	75%
Schwarz, 2008[64]	*Inclusion:* NYHA class 2-4, ≥65 years old, functionally impaired in at least 1 activity of daily living (ADL) or instrumental activity of daily living (IADL), assistance of a family caregiver, operating telephone line, and English speaking *Exclusion:* Planned discharge to a nursing home, inability to interview or contact, receiving regular infusions or dialysis	Home tele-monitoring plus usual care	51 (29/22)	77.1 ± 7.3	18% less than high school	NR	Class 2: 24% Class 3: 45% Class 4: 31%	NR
		Usual care	51 (20/31)	79.1 ± 6.9	51% less than high school	NR	Class 2: 18% Class 3: 51% Class 4: 31%	NR
Seibert, 2008[65]	*Inclusion:* CHF due to systolic dysfunction; NYHA calss II to IV, ejection fraction < 40%, ability to read and speak English, home phone, live at home, ≥ 18 years of age *Exclusion:* Renal dialysis, dementia or another unusual careled psychiatric disorder, anticipated survival < 6 months, participation in another HF research study in previous 6 months, receiving home health nursing service, heart transplant, pregnant or trying to become pregnant, blindness or inability to use upper extremities	Home telehealth	13 (8/5)	66 ± 9.1	Years of education 13.6 ± 9.1	NR	Average: 3.5 ± 0.7	NR
		Usual care	10 (8/2)	71 ± 13	Years of education 13.8 ± 1.7	NR	Average 3.11 ± 0.8	NR
Shah, 1998[80]	*Inclusion:* CHF patients admitted to the San Francisco Veterans Affairs Medical Centre, evidence of CHG for ≥ 6 months, LVEF ≤ o.35 *Exclusion:* History on non-adherence to	Both arms (pre-post study)	27 (27/0)	62 (range 42-81)	NR	0.20-0.35: 18 (67%) <0.20: 9 (33%)	Class 2: 10 (37%) Class 3-4: 17 (63%)	0.8 per patient-year

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
	physician appointments, previous acute myocardial infarction, cardiac surgery within 3 months of study, follow-up care not provided at the study medical centre							
Tsuyuki, 2004[81]	*Inclusion:* Hospitalization with diagnosis of HF *Exclusion:* Known secondary cause of HF, preserved systolic function, taking angiotensin II antagonist due to ACE inhibitor intolerance, terminal illness with life expectancy < 6 months, cognitive impairment, language barriers, enrolled in a HF clinical trial, residence outside region, not responsible for own medication	Pharmacist or nurse telephone monitoring	140 (81/59)	71 ± 12	NR	NR	Class 1: 12% Class 2: 48% Class 3: 35% Class 4: 5%	NR
		Usual care	136 (79/57)	72 ± 12	NR	NR	Class 1: 14% Class 2: 52% Class 3: 30% Class 4: 3%	NR
Vaccaro, 2001[66]	*Inclusion:* One in-patient admission or 3 ER visits for chronic HF in the prior year *Exclusion:* NR	Both arms	690 (304/386)	NR	NR	NR	NR	NR
Wheeler, 2006[82]	*Inclusion:* Patients from the health care agency with a primary diagnosis of HF *Exclusion:* NR	Telephone	20 (14/6)	70.6 ± 15.1	NR	NR	Class 1: 10% Class 2: 65% Class 3: 20% Class 4: 5%	NR
		Usual care	21 (13/8)	73.4 ± 10.3	NR	NR	Class 1: 14% Class 2: 48% Class 3:	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	LVEF (mean, SD)	NYHA class	Number of admissions in previous year
							38% Class 4: 0	
Woodend, 2008[67]	*Inclusion:* Symptomatic HF (NYHA class 2-4) or angina (CCS class 1 or greater), capable of reading or writing English or French, live within 100 km of the University of Ottawa Heart Institute, and provide informed consent *Exclusion:* Discharge from hospital to another institution or long-term care facility	Telehome monitoring	62 (46/16)	67 ± 13	NR	NR	Class 3-4: 66%	NR
		Usual care	59 (41/18)	66 ± 11	NR	NR	Class 3-4: 58%	NR

HF=heart failure; CHF=congestive heart failure; NYHA=New York Heart Association; LVEF=left ventricular ejection fraction

APPENDIX 5C: PATIENT BASELINE CHARACTERISTICS (COPD)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	FEV_1 (mean ± SD)	O_2 dependence (mean)	Number of admissions in previous year
Bourbeau, 2003[87]	*Inclusion:* Stable COPD, hospitalized at least once in previous year from acute exacerbation of COPD, ≥ 50 years of age, current or previous smoker, FEV1 25%-70% of predicted normal value *Exclusion:* Previous diagnosis of asthma, left congestive heart failure, terminal disease, dementia, or unusual careled psychiatric illness	Telephone monitoring	96 (50/46)	69.4 ± 6.5	NR	46	NR	158
		Usual care	95 (56/39)	69.6 ± 7.4	NR	45	NR	152
Casas, 2006[88]	*Inclusion:* COPD *Exclusion:* Not living in health care area, severe comorbid conditions, illiteracy, no phone access at home, admission to a nursing home	Integrated care with telephone monitoring	65 (50/15)	70 ± 9	Less than primary: 16 (25%)	43 ± 20	NR	1.0 ± 1.3
		Usual care	90 (79/11)	72 ± 9	Less than primary: 20 (22%)	41 ± 15	NR	0.6 ± 1.2
de Toledo, 2006[84]	*Inclusion:* COPD patients recruited during a hospital admission due to an acute episode *Exclusion:* NR	Home telehealth	67 (65/2)	71 ± 8	NR	42 ± 20%	NR	NR
		Usual care	90 (87/3)	72 ± 8	NR	42 ± 15%	NR	NR
Egan, 2002[89]	*Inclusion:* History of lung disease, ≥ 18 years of age, predicted FEV1 of 35%-50% for mild to moderate disease or < 35% for severe disease, adequate cognitive function *Exclusion:* NR	Telephone support	33 (12/21)	67.2	Secondary: 6 (18%) Post secondary: 10(31%)	NR	NR	NR
		Usual care	33 (20/13)	67.8	Secondary: 5 (15%) Post secondary: 9	NR	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	FEV_1 (mean ± SD)	O_2 dependence (mean)	Number of admissions in previous year
					(28%)			
Farrero, 2001[90]	*Inclusion:* COPD patients admitted to hospital, receiving oxygen therapy ≥ 6 months before entering study *Exclusion:* NR	Nurse telephone monitoring	60 (NR)	69 ± 8	NR	28 ± 8	NR	1.3 ± 1.4 (21 ± 26 days)
		Usual care	62 (NR)	69 ± 8	NR	27 ± 9	NR	1.4 ± 1.6 (22 ± 26 days)
Paré, 2006[83]	*Inclusion:* Newly admitted, severe COPD that required frequent home visits *Exclusion:* Psychological or psychiatric disorders, cognitive deficiency or visual or motor deficiency	Home telehealth	20 (13/7)	69	NR	NR	53%	NR
		Usual care	10 (5/5)	72	NR	NR	50%	NR
Trappenburg, 2008[85]	*Inclusion:* At least 1 COPD exacerbation in preceding 6 months, > 45 years of age, post-bronchodilator FEV1 <50% of predicted normal and reversibility <10% *Exclusion:* Lung cancer, severe neurological, musculoskeletal, or cardiovascular disorders, severe psychological or psychiatric deficiency, cognitive deficiency, or inability to read at a basic level	Home telehealth	59 (27/32)	69 ± 8	NR	42 ± 14	NR	27 (9.1 ± 20.6 days)
		Usual care	56 (34/22)	70 ± 10	NR	39 ± 11	NR	16 (6.56 ± 14.3 days)
Vontetsianos, 2005[86]	*Inclusion:* COPD, with ≥ 4 hospitalizations during the previous 2 years *Exclusion:* NR	Both arms	NR	NR	NR	NR	NR	37 (Pre-intervention)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	FEV_1 (mean ± SD)	O_2 dependence (mean)	Number of admissions in previous year
Wong, 2005[91]	*Inclusion:* COPD, Cantonese speaking, alert and oriented, contactable by phone *Exclusion:* Other major diseases, discharged to an old-age home, abuse of alcohol or drugs, psychiatric disease, dying	Nurse telephone monitoring	30 (27/3)	72.8 ± 8.3	No education: 11 (36.7%) Secondary and above: 5 (16.6%)	NR	NR	NR
		Usual care	30 (20/10)	74.4 ± 7.4	No education: 9 (30%) Secondary and above: 2 (6.7%)	NR	NR	NR

APPENDIX 5D: PATIENT BASELINE CHARACTERISTICS (MIXED CHRONIC DISEASES)

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	Number of admissions in previous year
Alkema, 2006[99]	*Inclusion:* Members of the four contracted medical groups, age ≥ 65 years, enrollment in the Medicare managed care plan for at least 1 year, score ≥ 4 (scale of 1-11) on the health care utilization algorithm *Exclusion:* Nursing home residents, persons enrolled in similar studies	Telephonic social care management	377 (133/244)	82.98 ± 7.12	NR	NR
		Usual care	404 (138/266)	83.66 ± 7.36	NR	NR
Chumbler, 2004[92]	*Inclusion:* Chronically ill veterans (hypertension, diabetes, respiratory disease, or heart disease), ≥ 2 service use visits (hospitalizations, emergency room visits, or unscheduled walk-in visits) in previous 12 months, care costing ≥ $25,000 in previous 12 months, available telephone service *Exclusion:* NR	Home telehealth	111 (111/0)	72.7 ± 9.3	Less than high school: 52.3% High school and beyond: 47.7%	NR
		Usual care	115 (115/0)	73.4 ± 7.2	Less than high school: 21.7% High school and beyond: 78.3%	NR
Dang, 2006[93]	*Inclusion:* Age ≥ 60 years, diagnosis of CHF, diabetes, and/or COPD, primary care provided by Miami VAMC, ≥ 1 hospital admission or 2 emergency department visits in preceding 6 months with cost to Miami VAMC of ≥ $25,000 in past year, active home telephone line *Exclusion:* Resident or imminent resident of nursing home, terminal illness	Both arms	59 (59/0)	71.8 ± 6.7	NR	20 hospital admissions in previous 6 months; 60 emergency dept visits in previous 6 months
Finkelstein, 2006[94]	*Inclusion:* Eligible to receive home nursing care for either CHF, COPD or chronic wound care; physically and cognitively able to use the equipment, or have a supportive care partner who would do so, living in a technically functional home environment	Video-conferencing and monitoring plus home visits	34 (17/17)	74.3 (range 60-96)	NR	NR

First author, Year	Inclusion / Exclusion Criteria	Comparison arms	Number of patients (male/ female)	Mean age (years ± SD)	Educational level (years)	Number of admissions in previous year
		Usual home care	19 (10/9)		NR	NR
Hopp, 2006[95]	*Inclusion:* ≥ 1 hospitalization, ≥ 2 emergency department visits, or ≥ 10 outpatient visits in the prior 12months *Exclusion:* Lacking a telephone, judged incapable of operating the telemedicine system if sufficient caregiver support was lacking, or survival expectation of < 6 months	Home telehealth	18 (18/0)	69.8 ± 11.6	12.2 ± 3.1	NR
		Usual care	19 (19/0)	69.5 ± 12.7	10.6 ± 2.3	NR
Johnston, 2000[96]	*Inclusion:* Diagnosis of CHF, COPD, cerebral vascular accident, cancer, diabetes, or secondary diagnosis of anxiety, needing wound care, ability to operate video system, safe home environment for the technology *Exclusion:* NR	Tele-home health	102 (42/60)	71 ± 12.91	NR	NR
		Usual care	110 (47/63)	69 ± 14.20	NR	NR
Kobb, 2003[97]	*Inclusion:* Veterans with multiple chronic diseases, high-use and high-cost health care utilization for study enrolment. A group with similar characteristics was used as comparator. *Exclusion:* NR	Home telehealth	281 (275/6)	72	NR	NR
		Usual care	1120 (1098/22)	70	NR	NR
Noel, 2004[98]	*Inclusion:* Frail elderly veterans with heart failure, COPD and/or diabetes, documented high use of healthcare services due to geographic, economic, physical, linguistic, technologic, and/or cultural factors *Exclusion:* NR	Home telehealth	47 (44/3)	72	NR	NR
		Usual care	57 (57/0)	70	NR	NR

APPENDIX 6A: CLINICAL STUDIES ON HOME TELEHEALTH FOR DIABETES

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Barnett et al., 2006;[22] *Retrospective, concurrent matched cohort*	C (Fair to good)	Home telemonitoring	# of pts hospitalized: 117/391 Bed DoC per pt: 15.6 #of pts visit ED: 234/391 # of ED visits per pt: 0.60 # of pts primary clinic visit: 188/391 # of pts specialist visit: 291/391	After usual careling for selection bias and intervening time factors, the Veterans Affairs Care Coordination Home Telehealth program was found to reduce avoidable health services for diabetes mellitus (such as hospitalizations) and reduced care coordinator-initiated primary are clinic visits.
		Usual care	# of pts hospitalized: 129/391 Bed DoC per pt: 20.7 #of pts visit ED: 192/391 # of ED visits per pt: 0.49 # of pts primary clinic visit: 162/391 # of pts specialist visit: 204/391	
Biermann et al., 2002;[23] *RCT*	C (Fair to good)	Home telemonitoring	HbA1c: 6.9±1.3	Telemanagement of insulin-requiring diabetic patients is a cost and time saving procedure for the patients and results in metabolic usual care comparable to usual outpatient management.
		Usual care	HbA1c: 7.0±1.0	
Bujnowska-Fedak, 2006;[24] *Observational study*	E (Poor)	Home telemonitoring	HbA1c, change in value: -2.3	The system [a patient unit and medical unit connected by a telecommunication network] appeared to be reliable and user-friendly for the patients.
		Usual care	HbA1c, change in value: -3.9	
Chase et al., 2003;[25] *RCT*	C (Fair to good)	Home telemonitoring	HbA1c: 8.6±1.2	This study shows that electronic transmission of blood glucose levels and other diabetes data biweekly results in a similar level of glucose usual care and incidence of acute diabetes complications when compared with current usual care.
		Usual care	HbA1c: 8.6±1.7	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Chumbler et al., 2005;[26] *Pre- post study*	B (Good)	Home telehealth	# of pts hospitalized: 95/445 Bed DoC per pt: 2.89 #of pts visit ED: 278/445 # of pts visit primary clinic: 283/445	The results need to be interpreted with caution due to the single-group study design. Ideally, future research should use a randomized usual careled trial design.
		Pre-home telehealth	# of pts hospitalized: 188/445 Bed DoC per pt: 5.89 #of pts visit ED: 311/445 # of pts visit primary clinic: 208/445	
Dang et al., 2007;[27] *Pre- post study*	D (Poor to fair)	Home telehealth	# of hospitalizations: 25 Bed DoC per pt: 3.63 HbA1c: 7.3±1.7	Care coordination, facilitated by telemedicine, appeared to improve glycaemic usual care in veterans with diabetes from diverse ethnic backgrounds, particularly African-Americans. This may reduce health-care resource utilization.
		Pre-home telehealth	# of hospitalizations: 31 Bed DoC per pt: 8.98 HbA1c: 7.6±1.8	
Harno et al., 2006;[28] *RCT*	C (Fair to good)	Home telemonitoring	# primary care visits per pt: 4.2 HbA1c: 7.32	Diastolic blood pressure, fasting plasma glucose, serum total cholesterol, serum LDL-cholesterol, and serum triglycerides were significantly lower in the study than in the usual care group. This was achieved with fewer visitsby study patients to doctors and nurses. The use of e-health in diabetes care for 12 months provided equivalent diabetic usual care to usual care and improved cardiovascular risk factors.
		Usual care	# primary visits per pt: 5.2 HbA1c: 7.83	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Jansà et al., 2006;[29] *RCT*	B (Good)	Home telemonitoring	HbA1c: 7.5±1.4	Intensive telematic follow-up achieves similar improvements in metabolic usual care, quality of life and self-management compared with intensive face-to-face follow-up with lower patient costs. However, improvement in communication technology is required to provide reliable health care and diabetes team cost reductions.
		Usual care	HbA1c: 7.7±0.9	
Kim et al., 2003;[43] *RCT*	C (Fair to good)	Telephone support	HbA1c: 8.8±0.9	These findings suggest that a nurse telephone intervention can improve HbA1c, diet and blood glucose testing adherence.
		Usual care	HbA1c: 7.6±1.0	
Kim et al., 2005;[30] *Pre- post study*	C (Fair to good)	Telephone support	HbA1c: Not reported	In conclusion, the results of this study suggest that this 12-week educational intervention using wire Internet and text messaging by cellular phone improved the levels of fasting plasma glucose, 2-hour postprandial blood sugar and patient satisfaction with care but did not affect the levels of total cholesterol, triglycerides and high-density lipoprotein cholesterol in type 2 diabetic patients..
		Pre-telephone support	HbA1c: 8.0±2.3	
Kwon et al., 2004:[31] *RCT*	A (High)	Home telemonitoring	HbA1c: 6.94±0.92	The Internet-based blood glucose monitoring system (IBGMS) resulted in a significant reduction of Hb1Ac during the study period. We propose that this IBGMS be used as a method for improving diabetes usual care.
		Usual care	HbA1c: 7.62±0.93	
Ladyzynski and Wojcicki, 2007;[32] *RCT*	D (Poor to fair)	Home telemonitoring	HbA1c: 6.8±0.9	The use of a home telecare system during intensive insulin treatment of pregnant type 1 patients with diabetes led to a significant improvement in glycaemic usual care among the patients. However, the mean metabolic usual care failed to meet expectations because the patient-collected data were
		Usual care	HbA1c: 6.7±0.9	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
				not fully utilized. This may be explained by too high within-day variation of the glycaemic usual care and the high workload connected with real-time data analysis..
Larizza , 2006;[33] *Prospective study*	D (Poor to fair)	Home telemonitoring	HbA1c: 9.05±1.72	The evaluation study showed that telemedicine intervention was satisfactory both for physicians because it allows to constantly monitor the patients' blood glucose level for patients since it increases their motivation to self-monitor the metabolic situation.
		Usual care	HbA1c: 8.03±1.0	
Liesenfeld et al., 2000;[34] *Pre/post study*	C (Fair to good)	Home telemonitoring	HbA1c (change in value): -0.4	Telemedical care (home telemonitoring) for intensive insulin therapy is safe, can improve glycemic usual care and reduce the number of hypoglycemias in children and adolescents with type 1 diabetes.
		Pre-home telemonitoring	HbA1c: Not reported	
Maljanian et al., 2005;[44] *RCT*	B (Good)	Nurse telephone support	HbA1c: 6.9±1.5	The additional telephone support further improved adherence to American Diabetes Association guidelines for self-care and medical care but did not affect glycemic usual care or health-related quality of life.
		Usual care	HbA1c: 6.6±1.1	
McMahon et al., 2005;[35] *RCT*	A (High)	Home telemonitoring	HbA1c: 8.4	Web-based care management may be a useful addition in the care of patients with poorly usual careled diabetes in the Veterans Affairs health care system.
		Usual care	HbA1c: 8.7	
Warren et al., 2000;[36] *RCT*	C (Fair to good)	Home telemonitoring	HbA1c: 8.2	Based on our experience, we present a functionally-based medicine classification system to improve the application of electronic medicine in future studies.
		Usual care	HbA1c: 8.6	
Meneghini et al., 1998;[37]	D (Poor to fair)	Home telemonitoring	HbA1c: 8.9±1.76	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Pre-post study		Pre-home telemonitoring	HbA1c: 9.8±1.71	Patients with diabetes who accessed the electronic case manager system received timely, cost-effective and reliable medical intervention. This reduced incidence of diabetic crises and the need for frequent clinic visits. The ECM empowers case managers to provide safer and superior diabetes care.
Piette, 2000;[45] *RCT*	A (High)	Nurse telephone support	Quality of life reported only	This intervention [automated telephone disease management with telephone nurse follow-up] had several positive effects on patient-centred outcomes of care but no measurable effects on anxiety or HRQL.
		Usual care		
Piette et al., 2001;[38] *RCT*	A (High)	Home telemonitoring	# of office visits per pt: 8.9 HbA1c: 8.1±1.15	The intervention [automated telephone disease management with telephone nurse follow-up] improved the quality of Veterans Affair diabetes care. Intervention effects for most end points replicated findings from the prior country clinic trial, although intervention-usual care differences in the current study year were smaller because of the relatively good self-care and health status among the current study's enrollees.
		Usual care	# of office visits per pt: 7.2 HbA1c: 8.2±1.18	
Shea et al., 2006;[39] *RCT*	A (High)	Home telemonitoring	HbA1c: 6.97±1.12	Telemedicine case management [a home telemedicine unit consisting of a web-enabled computer with modem connection] improved glycemic usual care, blood pressure levels and total and LDL cholesterol levels at one year of follow-up.
		Usual care	HbA1c: 7.17±1.40	
Thompson, 1999;[46] *RCT*	C (Fair to good)	Nurse telephone support	HbA1c: 7.8±0.8	Insulin adjustment based on advice from a diabetes nurse educator is an effective method in glucose usual care improvement in insulin-requiring patients with diabetes.
		Usual care	HbA1c: 8.9±1.0	
Tsang, 2001;[40] *RCT*	D (Poor to fair)	Home telemonitoring	HbA1c: 8.16±1.74	Ninety-five percent of the patients found the computerized diabetes monitoring system (DMS)

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
(crossover)		Usual care	HbA1c: 8.67±1.79	easy to operate, while 63% found it useful. The DMS was a feasible model of telemedicine in diabetes, and a larger study is required to examine its cost-effectiveness.
Vahatalo, 2004;[42] *Pre-post study*	E (Poor)	Home telemonitoring (cellular phone-based)	HbA1c: 8.15±1.3	The phone system worked well technically and none of the patients in the study had problems transmitting their glucose values. The phone system was not associated with overall improvement in glucose levels, probably due to the patients' low measurement activity.
		Pre-home telemonitoring	HbA1c: 8.25±1.5	
Wojcicki et al., 2001;[41] *RCT*	C (Fair to good)	Home telemonitoring	HbA1c: 6.8±0.9	This telematic intensive care system improved the effectiveness of diabetes treatment during pregnancy. It also allows the dibetologist's strategy for the Patient's care to be much more precise than if it were conducted without telematic support. This telematic system is inexpensive and simple in use.
		Usual care	HbA1c: 6.7±0.9	
Wong FKY et al., 2005;[47] *RCT*	A (High)	Nurse telephone support	# of pts rehospitalized: 1/52 #of pts visit ED: 0/52 HbA1c: 7.6±1.1	Nurse-follow-up is effective in maintaining optimal glycaemic usual care and enhancing adherence to health behaviours.
		Usual care	# of pts rehospitalized: 2/49 #of pts visit ED: 2/49 HbA1c: 8.1±1.5	

Bed DoC: Bed days of care for hospitalized patients; ED: Emergency department; HbA1c: Glycated hemoglobin (%mean ± SD); Pt: Patient; RCT: Randomized controlled trial

APPENDIX 6B: CLINICAL STUDIES ON HOME TELEHEALTH FOR HEART FAILURE

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Artinian, 2003;[48] *RCT*	C (Fair to good)	Home telemonitoring	QoL outcomes reported only	There are promising pilot results that, if replicated in a larger sample, may significantly improve care and outcomes for patients with heart failure.
		Usual care		
Barth, 2001;[68] *Prospective study*	D (Poor to fair)	Nurse telephone support	# of pts rehosp: 0/17 # of pts visit ED (HF-related): 0/17 # of HF-related ED visits for per pt: 0 # of primary care visits per pt: 0	The results of this study gave support to the contention that a structured nurse-managed postdischarge program improves outcomes from a quality-of-life perspective for CHF patients after discharge from the acute-care setting. However, costs were not improved. Because the sample cannot be generalized to the population of CHF patients as a whole, the implications must be considered within the context of the limitations of the study.
		Usual care	# of pts rehosp: 0/17 # of pts visit ED (HF-related): 1/17 # of HF-related ED visits per pt: 0.06 # of primary care visits per pt: 0.06	
Benatar et al., 2003;[49] *RCT*	A (High)	Home telemonitoring	# of HF-related hosp. per pt: 0.12 HF-related Bed DoC per pt: 0.46	The adaptation of the state-of-the-art computerized technology to closely monitor patients with HF with advanced-practice nurse care under the guidance of a cardiologist significantly improves HF management while reducing the cost of care.
		Usual care	# of HF-related hosp. per pt: 0.22 HF-related Bed DoC per pt: 0.97	
Bondmass et al., 1999;[50] *Pre-post study*	B (Good)	Home telemonitoring	# of all-cause hosp. per pt: 0.46 All-cause Bed DoC per pt: 2.19	Readmissions, length of stay, and hospital charges were all significantly ($p<0.001$) decreased compared to prestudy values and quality of life was significantly ($p=0.002$) improved from baseline.
		Pre-home telehealth	# of all-cause hosp. per pt: 1.54 All-cause Bed DoC per pt: 8.08	
Capomolla et al., 2004;[51]	B (Good)	Home telemonitoring	# of all-cause hosp.per pt: 0.33 # of HF-related hosp. per pt: 0.25	A management program delivered by a telemonitoring service can reduce health

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
RCT			# of all-cause ED visits per pt: 0.02 All-cause deaths: 5/67 HF-related deaths: 2/67	care demands by CHF patients.
		Usual care	# of all-cause hosp. per pt: 1.17 # of HF-related hosp. per pt: 0.88 # of all-cause ED visits per pt: 0.18 All-cause deaths: 7/66 HF-related deaths: 6/66	
Cleland et al., 2005;[52] *RCT*	A (High)	Home telemonitoring	# of pts rehosp: 80/163 # of all-cause hosp. per pt: 0.95 All-cause Bed DoC per pt: 10.9 # of all-cause ED visits per pt: 0.37 # of primary care visits per pt: 2.79 # of specialist visits per pt: 0.61 # of office visits per pt: 4.0 # of home visits per pt: 1.8 All-cause deaths: 28/163	Further investigation and refinement of the application of HTM are warranted because it may be a valuable role for the management of selected patients with heart failure.
		Nurse telephone support	# of pts rehosp: 85/170 # of all-cause hosp.per pt: 0.85 All-cause Bed DoC per pt: 14.8 # of all-cause ED visits per pt: 0.32 # of primary care visits per pt: 3.54 # of specialist visits per pt: 0.69 # of office visits per pt: 4.8 # of home visits per pt: 2.3 All-cause deaths: 27/170	
		Usual care	# of pts rehosp: 46/85 # of all-cause hosp.per pt: 0.81 All-cause Bed DoC per pt: 9.6 # of all-cause ED visits per pt: 0.09 # of primary visits per pt: 1.40	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# of specialist visits per pt: 0.40 # of office visits per pt: 2.2 # of home visits per pt: 0.8 All-cause deaths: 20/85	
Cordisco et al., 1999;[53] *Prospective study*	C (Fair to good)	Home telemonitoring	# of pts rehosp: 13/30 # of all-cause ED visits per pt: 0.03 All-cause deaths: 7/30	Our program, which was more narrowly focused on weights and symptoms, actually achieved the end point of reducing hospitalizations and emergency room visits.
		Usual care	# of pts rehosp: 36/51 # of all-cause ED visits per pt: 0.22 All-cause deaths: 11/51	
DeBusk et al., 2004;[69] *RCT*	A (High)	Nurse telephone support	# of pts rehosp: 116/228 # of all-cause hosp.per pt: 1.04 # of HF-related hosp per pt: 0.33 # of pts visit ED (all-cause): 126/228 # of all-cause ED visits per pt: 3.2 All-cause deaths: 21/228 HF-related deaths:13/228	Among patients with heart failure at low risk on the basis of sociodemographic and medical attributes, nurse care management did not statistically significantly reduce rehospitalizations for heart failure or for any cause. Such programs may be less effective for patients at low risk than those at high risk.
		Usual care	# of pts rehosp: 117/234 # of all-cause hosp.per pt: 0.99 # of HF-related hosp. per pt: 0.37 # of pts visit ED (all-cause): 132/234 # of all-cause ED visits per pt: 3.5 All-cause deaths: 29/234 HF-related deaths: 23/234	
Dunagan et al., 2005;[70] *RCT*	A (High)	Nurse telephone support	# of pts rehosp: 50/76 # of all-cause hosp per pt: 2.1 # of HF-related hosp per pt: 1.0 All-cause Bed DoC per pt: 13.3 All-cause deaths: 13/76	A nurse-administered, telephone-based disease management program delayed subsequent health care encounters, but had minimal impact on other outcomes,
		Usual care	# of pts rehosp: 55/75 # of all-cause hosp per pt: 2.3	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# of HF-related hosp per pt:1.0 All-cause Bed DoC per pt: 14.5 All-cause deaths : 11/75	
Galbreath et al., 2004;[71] *RCT*	B (Good)	Nurse telephone support	# of all-cause hosp per pt: 0.07 All-cause Bed DoC per pt: 0.35 # of HF-related ED visits per pt: 0.06 # of office visits per pt: 5.00 All-cause deaths: 54/710	Participation in DM resulted in a significant survival benefit, most notably in symptomatic systolic HF patients. Although DM was associated with improved NYHA class, 6-minute walk test results did not improve. Healthcare utilization was not reduced by DM, and it conferred no cost savings. DM in HF results in improved life expectancy but does not improve measures of functional capacity and does not reduce cost.
		Usual care	# of all-cause hosp per pt: 0.07 All-cause Bed DoC per pt: 0.34 # of HF-related ED visits per pt: 0.05 # of office visits per pt: 4.92 All-cause deaths: 39/359	
Gattis et al., 1999;[72] *RCT*	C (Fair to good)	Nurse telephone support	# of pts rehosp: 26/90 All-cause deaths: 3/90 HF-related deaths: 1/90	Outcomes in heart failure can be improved with a clinical pharmacist as a member of the multdiscplinary heart failure team. This observation may be due to higher does of angiotensin-converting enzyme inhibitors and/or closer follow-up.
		Usual care	# of pts rehosp: 38/91 All-cause deaths: 5/91 HF-related deaths: 1/91	
GESICA, 2005;[73] *RCT*	A (High)	Nurse telephone support	# of pts rehosp: 261/760 # pf pts rehosp (HF-related): 128/760 All-cause deaths: 116/760	This simple, centralised heart failure programme was effective in reducing the primary end point through a significant reduction in admissions to hospital for heart failure.
		Usual care	# of pts rehospitalized: 296/758 # pf pts rehosp (HF-related): 169/760 All-cause deaths: 122/758	
Giordano et al., 2008;[54] *RCT*	A (High)	Home telemonitoring	# of pts rehosp: 67/226 # of pts rehosp (cardio): 43/226 # of all-cause hosp. per pt: 0.40 All-cause deaths: 20/226 Cardio-related deaths: 18/226	This study suggests that one-year home-based telemanagement programme reduce hospital readmissions and costs in CHF patients.

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
		Usual care	# of pts rehosp: 96/229 # of pts rehosp (cardio): 73/229 # of all-cause hosp per pt: 0.62 All-cause deaths: 32/229 Cardio deaths: 29/229	
Goldberg et al., 2003;[55] *RCT*	B (Good)	Home telemonitoring	# of all-cause hosp per pt: 0.19±0.46 # of HF-related hosp per pt: 0.08±0.24 All-cause deaths: 11/138	This is the largest multicenter, randmoized trial of a technology-based daily weight and symptom-monitoring system for patients with advanced heart failure. Despite no difference in the primary care end point of rehospitalisation rates, mortality was significantly reduced for patients randomized to the ALereNetSystem without an increase in utilization, despite specialized and aggressive heart failure care in both groups.
		Usual care	# of all-cause hosp per pt: 0.20±0.30 # of HF-related hosp per pt: 0.11±0.26 All-cause deaths: 26/142	
Heidenreich et al., 1999;[74] *Prospective study*	D (Poor to fair)	Nurse telephone support	# of all-cause hosp per pt: 1.9±3.8 All-cause Bed DoC per pt: 4.8±10	These findings suggest that a multidisciplinary program of patient education, monitoring, and physician notification can reduce use in patients with heart failure managed in a community setting.
		Usual care	# of all-cause hosp per pt: 3.4±6.7 All-cause Bed DoC per pt: 17±38	
Jerant et al., 2001, 2003;[56,102] *RCT*	B (Good)	Home telemonitoring	# of all-cause hosp per pt: 0.7±1.7 # of HF-related hosp per pt: 0.1±0.3 # of all-cause ED visits per pt: 0.7±1.4 # of HF-related ED visits per pt: 0.1±0.3 # of home visits per pt: 2.3±0.6 All-cause deaths: 0/13	Telenursing can reduce CHF hospitalizations and allow increased frequency of communication with patients.[56] Substantial reductions in hospital readmissions, emergency visits, and cost of care for patients with CHF might be achieved by widespread deployment of
		Nurse telephone support	# of all-cause hosp per pt: 0.5±0.7 # of HF-related hosp per pt: 0.1±0.3	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# of all-cause ED visits per pt: 0.7±0.8 # of HF-related ED visits per pt:0.2±0.4 # of home visits per pt: 1.9±0.3 All-cause deaths: 2/12	distane technology to provide posthospitalization monitoring. Home telecare may not offer incremental benefit beyond telephone follow-up and is more expensive.[102]
		Usual care	# of all-cause hosp per pt: 1.2±1.9 # of HF-related hosp per pt: 0.3±0.5 # of all-cause ED visits per pt: 1.8±2.5 # of HF-related ED visits per pt:0.7±0.9 # of home visits per pt: 2.0±0.0 All-cause deaths: 0/12	
Krumholz et al., 2002;[75] *RCT*	B (Good)	Nurse telephone support	# of pts rehosp (all-cause): 25/44 # of pts rehosp (HF-related): 18/44 # of all-cause hosp per pt: 1.11 # of HF-related hosp per pt: 0.5 All-cause Bed DoC per pt: 10.2±16.8 HF-related Bed DoC per pt: 4.1±6.4 All-cause deaths: 9/44	A formal education and support intervention substantially reduced adverse clinical outcomes and costs for patients with HF.
		Usual care	# of pts rehosp (all-cause): 36/44 # of pts rehosp (HF-related): 30/44 # of all-cause hosp per pt: 1.82 # of HF-related hosp per pt: 0.95 All-cause Bed DoC per pt: 15.2±17.5 HF-related Bed DoC per pt: 7.6±12.1 All-cause deaths: 13/44	
LaFramboise et al., 2003;[57] *RCT*	D (Poor to fair)	Home telemonitoring	QoL outcomes reported only	These findings suggest that delivering a disease management program through a telehealth communication device is feasible and may be as effective as traditional methods.
		Nurse telephone support		
		Usual care		

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Laramee et al., 2003;[76] *RCT*	A (High)	Nurse telephone support	# of all-cause hosp per pt: 49/131 # of HF-related hosp per pt: 18/131 All-cause deaths: 12/131	These results suggest several limitations to the generalizability of the CHF case management-improved outcome link in a hetergenous setting. One explanation is that the lack of coordinated system supports and varied accessibility to care in an extended, nonnetworked physician setting limits the effectiveness of the case management.
		Usual care	# of all-cause hosp per pt: 46/125 # of HF-related hosp per pt: 21/131 All-cause deaths: 13/125	
de Lusignan, 2001;[58] *RCT*	D (Poor to fair)	Home telemonitoring	QoL outcomes reported only	Home telemonitoring is an acceptable reliable intervention. Baseline rates for compliance with self-monitoring are set out in this study. Benefit in terms of compliance with medication and self-monitoring is still seen after 1 year. Video consulting over ordinary telephone lines did not show sustained benefit, and was not complied with.
		Usual care		
McManus, 2004;[59] *Prospective study*	D (Poor to fair)	Home telemonitoring	# of HF-related hosp per pt: 0.05	The data were not statistically significant; however, during each of the time periods, fewer telehealth patients were readmitted to the hospital for CHF than those receiving regular home care.
		Usual care	# of HF-related hosp per pt: 0.15	
Mehra et al., 2000;[60] *Prospective study*	D (Poor to fair)	Home telemonitoring	# of all-cause hosp per pt: 0.21 All-cause Bed DoC per pt: 1.21 # of all-cause ED visits per pt: 0.04	Preliminary data with the HomMed Sentry™ -Observer™ system suggest that this technique is clinically reliable, accurate and associated with trends in improved medical resource utilization parameters. Further large scale investigations of this clinical approach are warranted.
		Usual care	# of all-cause hosp per pt: 0.35 All-cause Bed DoC per pt: 1.97 # of all-cause ED visits per pt: 0.22	
Myers et al., 2006[61]	C (Fair to good)	Home telemonitoring	# of all-cause hosp per pt: 0.2±0.5 # of all-cause ED visits per pt:	Daily home care telemonitoring reduced the frequency of home nursing visits, provided

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Prospective study			0.05±0.2 # of home visits per pt: 5.8±1.6	cost savings and was associated with improved self-perceived quality-of-life.
		Usual care	# of all-cause hosp per pt: 0.3±0.8 # of all-cause ED visits per pt: 0.05±0.2 # of home visits per pt: 8.2±2.4	
Quinn, 2006;[77] *Prospective study*	D (Poor to fair)	Nurse telephone support	# of pts rehosp: 2/17 # of home visits per pt: 0.43	In conclusion, this study demonstrated that a structured intervention decreased emergent care visits and reduced nursing visits, allowing for the provision of care of patients with HF in a more effective and efficient manner than usual care.
		Usual care	# of pts rehosp: 4/5 # of home visits per pt: 2.48	
Riegel et al., 2002;[78] *Cluster RCT*	C (Fair to good)	Nurse telephone support	# of all-cause hosp per pt: 0.62±0.88 # of HF-related hosp per pt: 0.21±0.5 All-cause Bed DoC per pt: 3.5±6.6 HF-related Bed DoC per pt: 1.1±3.1 # of all-cause ED visits per pt: 0.14±0.45 # of primary care visits per pt: 5.63±3.6	The reduction in hospitalizatios, costs, andother resource use achieved using standardized telephonic case management in the early months after a heart failure admission is greater than that usually achieved with pharmaceutical therapy and comparable with other disease management approaches.
		Usual care	# of all-cause hosp per pt: 0.87±1.1 # of HF-related hosp per pt: 0.41±0.77 All-cause Bed DoC per pt: 4.8±8.3 HF-related Bed DoC per pt: 2.1±4.6 # of all-cause ED visits per pt: 0.11±0.34 # of primary care visits per pt: 6.17±4.87	
Riegel et al., 2006;[79] *RCT*	A (High)	Nurse telephone support	# of pts rehosp (all-cause): 40/69 # of pts rehosp (HF-related): 22/69 # of all-cause hosp per pt: 1.06±1.3	These results have important implications because of the current widespread enthusiasm for disease management.

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# HF-related hosp per pt: 0.55±1.1 All-cause Bed DoC per pt: 6.33±9.4 HF-related Bed DoC per pt: 3.65±7.8	Although disease management is effective in the mainstream HF patient population, in Hispanics this ill, elderly, and poorly educated, a different approach may be needed.
		Usual care	# of pts rehosp (all-cause): 40/65 # of pts rehosp (HF-related): 22/65 # of all-cause hosp per pt: 1.08±1.4 # of HF-related hosp per pt: 0.49±0.81 All-cause Bed DoC per pt: 7.41±8.9 HF-related Bed DoC per pt: 3.40±7.1	
Roth et al., 2004;[62] *Pre-post study*	C (Fair to good)	Home telemonitoring	HF-related Bed DoC per pt: 5.87	Data are provided to demonstrate that a transtelephonic system allowing primary care at the patient's home can significantly reduce hospitalization rate and length of stay and significantly enhance the quality of life of patients with chronic heart failure,
		Pre-home telehealth	HF-related Bed DoC per pt: 13.75	
Schofield et al., 2005[63] *Pre-post study*	B (Good)	Home telemonitoring	All-cause Bed DoC per pt: 1.65±5.4	Our nurse-directed, care coordinated home telehealth management team program was associated with improved early outcomes in a groups of elderly male verterns with chronic HF.
		Usual care	All-cause Bed DoC per pt: 8.63±9.6	
Schwarz, 2008;[64] *RCT*	A (High)	Home telemonitoring	# of pts rehosp: 12/44 # of all-cause hosp per pt: 0.32±0.6 # of all-cause ED visits per pt: 0.34±0.6 All-cause deaths: 4/44	There were no significant differences due to telemonitoring for any outcomes. Caregiver mastery, informal social support, and electronic home monitoring were not significant predictors for risk of hospital admission. Further studies should address the interaction between the advanced practice nurse and follow-up intervention with telemonitoring of patients with HF to better target those who are most likely to benefit.
		Usual care	# of pts rehosp: 13/40 # of all-cause hosp per pt: 0.33±0.6 # of all-cause ED visits per pt: 0.38±0.6 All-cause deaths: 7/40	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Seibert et al., 2008;[65] *Prospective study*	E (Poor)	Home telemonitoring	# of all-cause hosp per pt: 0.46 # of all-cause ED visits per pt: 0.15 # of primary care visits per pt: 0.85	Our reviw of the literature also supports the role of telemedicine in facilitating home health care and self-management for CHF patients. There are many challenges still to be addressed before this potential can be reached and further research is needed to identify opportunities in telemedicine.
		Usual care	# of all-cause hosp per pt: 0.1 # of all-cause ED visits per pt: 0.3 # of primary care visits per pt: 1.00	
Shah et al., 1998;[80] *Pre-post study*	D (Poor to fair)	Nurse telephone support	# of all-cause hosp per pt: 0.4 All-cause Bed DoC per pt: 0.8	This preliminary experience suggests that close telephone monitoring by personnel from an independent service can prevent hospitalizations for heart failure among both recently discharged patients and ambulatory outpatients and among both elderly and middle-aged persons.
		Usual care	# of all-cause hosp per pt: 0.8 All-cause Bed DoC per pt: 9.5	
Tsuyuki et al., 2004;[81] *RCT*	A (High)	Nurse telephone support	# of pts rehosp (all-cause): 59/140 # of pts rehosp (HF-related): 37/140 # of all-cause hosp per pt: 0.68 # of HF-related hosp per pt: 0.38 All-cause Bed DoC per pt: 4.48 # of pts visit ED (all-cause): 31/140 # of pts visit ED Hf-related): 12/140 # of all-cause ED visits per pt: 0.3 # of HF-related ED visits per pt: 0.14 # of all-cause primary care visits per pt: 6.7 # of HF-related primary care visits per pt: 1.6±1.44) All-cause deaths: 16/140	A simple and practical in-hospital HF disease management program improved the utilization of ACE inhibitors by almost 50% and also promoted the usage of higher doses of ACE inhibitors. A-month patient education and support program for outpatients with HF has little impact on ACE inhibitor adherence however reduced utilization of health care resources, resulting in cost-reduction of $CDN 2,531 per patient. Given the high prevalence and poor outcomes in this patient population, strong consideration should be given to implementation of such programs on a wider scale.
		Usual care	# of pts rehosp (all-cause): 51/136 # of pts rehosp (HF-related): 38/136 # of all-cause hosp per pt: 0.72	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# of HF-related hosp per pt: 0.51 All-cause Bed DoC per pt: 7.96 # of pts visit ED (all-cause): 38/136 # of pts visit ED (HF-related): 29/136 # all-cause ED visits per pt: 0.51 # of HF-related ED visits per pt: 0.36 # of all-cause primary care visits per pt: 6.6 # of HF-related primary care visits per pt: 1.9±1.71 All-cause deaths: 12/136	
Vaccaro et al., 2001;[66] *Pre-post study*	D (Poor to fair)	Home telemonitoring	# of all-cause hosp per pt: 0.65 # of all-cause ED visits per pt: 0.17	The program effectively reduced impatient hospitalizations by 49.6% (p-value<0.001) and reduced ER visits by 73.0% (p-value<0.001). With a program enrolment of 700 patients, projected net annualized savings are approximately $2.7 million, and reutn on investment close to 200%.
		Usual care	# of all-cause hosp per pt: 1.29 # of all-cause ED visits per pt: 0.63	
Wheeler and Waterhouse, 2006;[82] *Prospective study*	D (Poor to fair)	Nurse telephone support	# of pts rehosp: 3/20	Patients who received telephone interventions had fewer hospital readmissions (13%) than the comparison group (35%). Patients in the telephone intervention group also had fewer overt heart failure symptoms as measured by the Minnesota Living With Heart Failure Questionnaire.
		Usual care	# of pts rehosp: 7/20	
Woodend et al., 2008;[67] *RCT*	B (Good)	Home telemonitoring	# of all-cause hosp per pt: 0.40 # of HF-related hosp per pt: 0.46 All-cause Bed DoC per pt: 2.11 HF-related Bed DoC per pt: 2.69	Telehealth technologies are a viable means of providing home monitoring to patients with heart disease at high risk of hospital readmission to improve their self-care abilities.
		Usual care	# of all-cause hosp per pt: 0.59	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			# of HF-related hosp per pt: 0.49 All-cause Bed DoC per pt: 3.93 HF-related Bed DoC per pt: 3.75	

BedDoC: Bed days of care; Cardio: Cardiovascular; CHF: Chronic heart failure; DM: Disease management; ED: Emergency department; Hosp.: Hospitalization; Pt:Patient; QoL: Quality of life; RCT: Randomized controlled trial; Rehosp: Rehospitalization

APPENDIX 6C: CLINICAL STUDIES ON HOME TELEHEALTH FOR COPD

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Bourbeau et al., 2003;[87] *RCT*	A (High)	Nurse telephone support	# of pts rehospitalized: 31/96 # of hospitalizations per pt: 0.96 Bed DoC per pt: 7.2±19.5 # of pts visit ED: 39/96 # of ED visits per pt: 1.58 # visits to primary care per pt: 0.48 # visits to specialist per pt: 0.25 Deaths: 9/96	A continuum of self-management for COPD patients provided by a trained health professional can significantly reduce the utilization of health care services and improve health status. This approach of care can be implemented within normal practice.
		Usual care	# of pts rehospitalized: 48/95 # of hospitalizations per pt: 1.76 Bed DoC per pt: 12.5±21.2 # of pts visit ED: 60/95 # of ED visits per pt: 2.47 # visits to primary care per pt: 1.18 # visits to specialist per pt: 0.27 Deaths: 5/95	
Casas et al., 2006; [88] *RCT*	A (High)	Nurse telephone support	# of hospitalizations per pt: 1.5±2.6 Deaths: 12/65	In conclusion, this trial demonstrates that a standardised integrated care intervention, based on shared care arrangements among different levels of the system with support of informatipn technologies, effectively prevents hospitalizations for exacerbations in chronic obstructive pulmonary disease patients.
		Usual care	# of hospitalizations per pt: 2.1±3.1 Deaths: 14/90	
Egan et al., 2002; [89] *RCT*	D (Poor to fair)	Nurse telephone support	# of hospitalizations per pt: 2.1	There was little difference between groups in terms of unplanned readimissions, depression, symptoms, support, and subjective well being. Interviews with patients and caregivers found that the case management improved access to resources and staff-patients communication. Inteviews with nursing and medical staff found that case management improved communication between staff and enhanced patient care.
		Usual care	# of hospitalizations per pt: 2.6	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Farrero et al., 2001;[90] *RCT*	B (Good)	Nurse telephone support	# of hospitalizations per pt: 0.5±0.86 Bed DoC per pt: 7.43 ±15.6 # of ED visits per pt: 0.45±0.83 Deaths: 23/60 (16/60)	Hospital-based home care is an effective alternative to hospital admission. It reduces the use of hospital resources and the cost of health care.
		Usual care	# of hospitalizations per pt: 1.29±1.7 Bed DoC per pt: 18.20 ±24.55 # of ED visits per pt: 1.58±1.96 Deaths: 21/62 (14/62)	
Paré, 2006;[83] *Quasi-experimental study*	C (Fair to good)	Home telemonitoring	# of hospitalizations per pt: 0.1 Bed DoC per pt: 13.5 # of home visits per pt: 4.2	Patients were found to easily accept the idea of using the technology, and the telehomecare program demonstrated significant clinical benefits. Financial advantages of the program could have been more pronounced had it not been for the cost of technology that effectively erased a good portion of the savings.
		Usual care	# of hospitalizations per pt: 0.6 Bed DoC per pt: 7.3 # of home visits per pt: 7.5	
de Toledo et al., 2006;[84] *RCT*	B (Good)	Home telemonitoring	# of pts rehospitalized: 31/67 # of hospitalizations per pt: 0.90±1.28 # of ED visits per pt: 0.36±0.98 Deaths: 14/67	We have found that simple telemedicine services (ubiquitous access to electrnic chronic patient record-ECPR, ECPR shared by care team, accessibility to case manager, problem reporting integrated in ECPR) can increase the number of patients that were readmitted (51% intervention, 33% usual care), are acceptable to professionals, and involve low installation and exploitation costs. Further research is needed to determine the role of telemonitoring and televist services for this kind of patients.
		Usual care	# of pts rehospitalized: 59/90 # of hospitalizations per pt: 1.33±1.73 # of ED visits per pt: 0.54±1.12 Deaths: 15/90	
Trappenburg et al., 2008;[85] *Prospective study*	B (Good)	Home telemonitoring	# of hospitalizations per pt: 0.65±1.3 Bed DoC per pt: 6.6±24.0 # of office visits per pt: 3.23±2.2	Compared with a group of patients receiving care as usual, in the Health Buddy group there was a decrease in the number of exacerbations and hospital admissions. It seems likely that adopting telemonitoring in everyday clinical practice is feasible and can substantially improve care and
		Usual care	# of hospitalizations per pt: 0.75±1.2	

Authors, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			Bed DoC per pt: 7.46±19.9 # of office visits per pt: 2.3±1.3	decrease healthcare utilization of moderate to severe COPD patients.
Vontetsianos et al., 2005;[86] *Pre-post study*	D (Poor to fair)	Home telemonitoring	# of hospitalizations per pt: 0.33 Bed DoC per pt: 3.6 # of office visits per pt: 4.8	After nine months, there was a decrease in hospitalizations, emergency department visits and use of health services. The patient's disease knowledge and self-management also improved. It seems likely that adopting telemedicine in everday clinical practice could substantially improve the care of chronically ill patients.
		Pre-home telehealth	# of hospitalizations per pt: 2.1 Bed DoC per pt: 17.5 # of office visits per pt: 8.7	
Wong, 2005;[91] *RCT*	B (Good)	Nurse telephone support	# of hospitalizations per pt: 0.6±1.0 Bed DoC per pt: 19.6±2.5 # of ED visits per pt: 0.1±0.3 # of office visits per pt: 5.0	Nurse-initiated telephone follow-up care was effective in increasing self-efficacy to managing dysponea. The study needs to be replicated in other setting to strengthen its external validity.
		Usual care	# of hospitalizations per pt: 1.1±1.3 Bed DoC per pt: 17.3±4.4 # of ED visits per pt: 0.4±0.7 # of office visits per pt: 6.0	

Bed DoC: Bed days of care for hospital admission; ED: Emergency department; Pt: Patient; RCT: Randomized controlled trial

APPENDIX 6D: CLINICAL STUDIES ON HOME TELEHEALTH FOR MIXED CHRONIC DISEASES

First author, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Alkema, 2007;[99] *RCT*	C (Fair to good)	Nurse telephone support	Deaths: 51/377	Findings suggest that the care advocate model of social care management affected mortality while the program was in progress, but not after completion of the intervention phase. Key model elements accounted for the findings, which include individualized targeting, assessment, and monitoring; consumer choice, usual care, and participant self-management; and bridging medical and social delivery systems through direct linkages and communication.
		Usual care	Deaths: 90/404	
Chumbler, 2004;[92] *Case-usual care study*	D (Poor to fair)	Home telemonitoring	QoL outcomes were reported only.	This evidence supports the use of a specific home-telehealth strategy fo care coordination to improve functional independence in non-institutionalized verterans with chronic disease. A randomized usual care trial should be employed to confirm these findings.
		Usual care		
Dang et al., 2006;[93] *Pre-post study*	C (Fair to good)	Home telemonitoring	# of hospitalizations per pt: 0.5±1.1 Bed DoC per pt: 5.1±11.4 # of ED visits per pt: 0.92±1.69 # of office visits per pt: 5.5±3.3	We found that telecare models may reduce resource utilization in elderly patients with chronic diseases, especially in patients with CHF. Because of the small sample size and lack of usual cares, larger and more carefully designed follow-up trials are needed to determine cost efficiency for different chronic diseases, and the relative value of the interpersonal contact versus the technological components of this care coordination model.
		Pre-home telehealth	# of hospitalizations per pt: 0.9±1.5 Bed DoC per pt: 6.1±9.2 # of ED visits per pt:	

First author, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			1.08±1.33 # of office visits per pt: 6.4±4.0	
Finkelstein et al., 2006;[94] *RCT*	C (Fair to good)	Home telemonitoring	# of pts rehospitalized: 6/34 Deaths: 7/34	This study has demonstrated that virtual visits between a skilled home health care nurse and chronically ill patients at home can improve patient outcome at lower cost than traditional skilled face-to-face home healthcare visits.
		Usual care	# of pts rehospitalized: 8/19 Deaths: 5/19	
Hopp et al., 2006;[95] *RCT*	C (Fair to good)	Home telemonitoring	# of hospitalizations per pt: 0.67±1.03 Bed DoC per pt: 2.83±4.12 # of ED visits per pt: 1.00±1.33 # primary care visits per pt: 3.39±3.85 # specialist visits per pt: 2.06±2.49 # of office visits per pt: 29.06±30.11	The use of telehealth services as an adjunct to traditional home care is associated with greater improvements in mental health status and a trend toward lower use of inpatient and outpatient healthcare services. Further work, utilizing larger sample sizes, is needed to investigate the relationship between telehealth services, the use of health care resources, and other outcomes.
		Usual care	# of hospitalizations per pt: 1.26±2.00 Bed DoC per pt: 7.11±12.86 # of ED visits per pt: 2.11±2.89 # primary care visits per pt: 3.89±5.03 # specialist visits per pt: 2.47±2.61 # of office visits per pt: 38.89±28.99	

First author, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
Johnston et al., 2000;[96] *RCT*	C (Fair to good)	Home telemonitoring	# of home visits per pt: 9.8	Remote video technology in the home health care setting was shown to be effective, well received by patients, capable of maintaining quality of care, and to have the potential for cost savings. Patients seemed pleased with the equipment and the ability to access a home health care provier 24 hours a day. Remote technology has the potential to effect cost savings when used to substitute some in-person visits and can also improve access to home health care staff for patients and caregivers. This technology can thus be an asset for patients and providers.
		Usual care	# of home visits per pt: 11.1	
Kobb et al., 2003;[97] *Quasi-experimental study*	D (Poor to fair)	Home telemonitoring	Bed DoC change per pt: -68% # of ED visits change per pt: -66% # of office visits change per pt: -4%	Findings demonstrate that care coordination enhanced by technology reduces hospital admissions, bed days of care, emergency room visits, and prescriptions as well as providing high patient and provider satisfaction. Verterans also had improved perception of physicial health as evidence by a standardized functional status measure.
		Usual care	Bed DoC change per pt: +32% # of ED visits change per pt: +22% # of office visits change per pt: +19%	
Noel et al., 2004;[98] *RCT*	B (Good)	Home telemonitoring	Bed DoC per pt: 1.88±3.33 # of ED visits per pt: 5.39±5.50 # of office visits per pt: 14.83±11.28 # of home visits per pt:	Integrating home telehealth with the healthcare institution's electronic database significantly reduces resource use and improves cognitive status, treatment compliance, and stability of chronic disease for home bound elderly with complex co-morbidities.

First author, year; *study design*	Quality score	Treatment	Outcomes	Conclusions (verbatim)
			2.00±4.60	
		Usual care	Bed DoC per pt: 5.11±10.54 # of ED visits per pt: 5.69±6.01 # of office visits per pt: 14.96±15.09 # of home visits per pt: 1.81±5.66	

Bed DoC: Bed days of care for hospitalized patients; ED: Emergency department; Pt: Patient; QoL: Quality of life; RCT: Randomized controlled trial

APPENDIX 7A: QUALITY OF LIFE (DIABETES)

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
Biermann (2002)[23]	Patient satisfaction questionnaire	Home telehealth	85% of telecare patients felt that telecare was better than conventional care (being better surveillance of blood glucose data by the physician, faster intervention in the case of problems, and no waiting time and travel times for consultations)	Most telecare patients felt that telecare was better than conventional care
		Usual care	Data not available	
Bujnowska-Fedak (2006)[24]	NR	Home telehealth	QoL: Slightly improved (score 3.4) Two-thirds of patients required family support to use the system and were not able to send the data on their own. 9% reported technical problem with the system 75% wanted to continue	The system seems to be reliable, simple to use and friendly to the user
		Usual care	QoL: Slightly improved (score 3.2), NS between treatments 60% wanted to be included in the telemedicine group	
Chase (2003)[25]	A Patient Satisfaction Questionnaire (Scale 1-7, with 1 being the most favorable)	Modem transmission review and telephone follow-up	Satisfaction: 2.6	Both groups expressed high satisfaction with their overall diabetic care, with no statistically significant difference between the groups.
		Usual care	Satisfaction: 2.2, NS	
Chumbler (2005) [26]	SF-36V (eight subscales)	Before	Role-physical: 40.6 ± 2.1 Bodily pain: 53.1 ± 2.1 Social functioning: 56.5 ±2.1	After 1 year of home telehealth, there were significant improvements in three of the eight SF-36V scales: Role-physical, Bodily pain and Social functioning

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
		After home telehealth	Role-physical: 46.1 ± 2.2, p=0.165 (improve) Bodily pain: 60.8 ± 2.1, p=0.0005 (improve) Social functioning: 61.0 ± 2.2, p=0.0498 (improve)	
Jansà (2006)[29]	Diabetes quality of life score (DQOL) (lower score, better perception) SF-12 health survey (higher score, better perception) Knowledge test DKQ2 (Max score 35)	Telecare	DQOL Satisfaction: Before: 37 ± 9; After: 33 ± 6, NS Impact: Before: 44 ± 6; After: 41 ± 7, NS Social worry: Before: 14 ± 2; After: 14 ± 3, NS Diabetes worry: Before: 8 ± 1; After: 8 ± 2, NS SF-12: Before: 37 ± 4; After: 37 ± 3, NS DKQ2: Before: 27 ± 4; After: 29 ± 3, p=0.05	Improvement was observed in both groups in the DQOL scores, being only significant in the usual care group for impact scale between baseline and 6-months follow-up. The General Health Status SF12 test did not change during the study in either group. There was significant increase in the knowledge test DQK2 scores Telematic follow-up achieves similar results to those of face-to-face follow-up
		Conventional	DQOL Satisfaction: Before: 28 ± 7; After: 27 ± 5, NS Impact: Before: 43 ± 7; After: 38 ± 6, p=0.05 Social worry: Before: 13 ± 3; After: 12 ± 5, NS Diabetes worry: Before: 8 ± 2; After: 7 ± 1, NS SF-12: Before: 37 ± 3; After: 37 ± 4, NS DKQ2: Before: 26 ± 4; After: 29 ± 4, p=0.05	
Kim (2005)[30]	Visual analogue scale	Before	Satisfaction: 68.6 ± 19.3	Care satisfaction was significantly increased after 12 weeks of intervention
		After (cellular phone and internet)	Satisfaction: 79.5 ± 20.0, p=0.03	
Maljanian (2005)[44]	SF-36, eight subscales of the general health-related	Telephone monitoring	Data not shown	There were no differences between groups on glycemic usual care,

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
	quality of life (HRQOL), The Diabetes Specific Quality of Life Questionnaire, The five-item Center for Epidemiologic Studies Depression Scale (CES-D), DQIP scale for patient satisfaction			HRQOL, symptom depression or patient satisfaction
		Usual care	Data not shown	
Warren (2000)[36]	Diabetes quality of Life (DQOL) survey and Medical Outcome Study Heath Survey SF-36	Home telehealth	Data not shown	No significant difference between treatments was found for he DQOL questionnaire and the Medical Outcome Study Heath Survey SF-36 during 3=-month period. A survey of the physicians and case manager on the usefulness of the technology showed that the subjective benefit was high, but the technology problems were a major obstacle.
		Usual care	Data not shown	
Piette (2000)[45]	CES-D depression screener, Anxiety subscale of the Rand Mental Health Inventory, Self-efficacy questionnaire, Days in bed and days cut down because of illness questionnaires, Diabetes-specific HRQL, Employee Health Care Value Survey, and SF-36 subscales	Automated telephone disease management	Depression 13.7 ± 1.2 Self-efficacy 4.5 ± 0.1 Days in bed because of illness 0.5 ± 0.2 Satisfaction with care 3.5 ± 0.1	Patients in the intervention group reported fewer symptoms of depression, greater self-efficacy to conduct self-care activities, and fewer days in bed because of illness compared with the usual care group. No intervention effects were observed on diabetes-specific HRQL, measured by either the diabetic quality of life summary scale or any of the 3 subscales. English-speaking patients in the intervention group were more satisfied than those in the usual care group with their health

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
				care.
		Usual care	Depression 17.6 ± 1.2, p=0.023 Self-efficacy 4.2 ± 0.1, p=0.006 Days in bed because of illness 1.0 ± 0.2, p=0.026 Satisfaction with care 3.3 ± 0.1, p=0.025	
Piette (2001)[38]	Employee Health Care Value Survey and questions regarding self-care behavior, symptoms, and perceptions regarding telephone care	Automated telephone disease management	All symptoms: 3.7 ± 0.2 Satisfaction • Summary scale: 3.8 ± 0.05 • Interpersonal aspect of care: 4.1 ± 0.1 • Quality of outcomes: 4.1 ± 0.1	Patients in the intervention reported fewer symptoms of poor glycemic usual care and had significant more satisfaction with care than patients receiving usual care
		Usual care	All symptoms: 4.4 ± 0.2, p=0.04 Satisfaction • Summary scale: 3.7 ± 0.04, p=0.05 • Interpersonal aspect of care: 3.9 ± 0.1, p=0.01 • Quality of outcomes: 3.8 ± 0.1, p=0.002	
Wong (2005)[47]	Patient satisfaction questionnaire (13 items encompassing aspects of diabetes education, intervention and services from diabetes nurses)	Nurse telephone monitoring	Satisfaction: 18.8 ± 5.8	There was no statistical difference for patient satisfaction between study and usual care groups
		Usual care	Satisfaction: 18.0 ± 5.8, NS	

NR: not reported; QoL: quality of life; NS: not significantly different

APPENDIX 7B: QUALITY OF LIFE (HEART FAILURE)

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
Artinian (2003)[48]	Revised Heart Failure Self-Care Behavior Scale, Minnesota Living with Heart Failure Questionnaire (QoL), 6 minute walk test, and NYHA FC	Web-based intervention (compliance device) + usual care	Self-care behavior: 106 ± 21 Total QoL: 38 ± 25 6-minute walk test (feet): 995 ± 275 NYHA FC: 2 ± 1.01	There were no differences between the compliance device group and the usual care group in self-care behaviors, pill counts, 6-minute walk test distance, or functional class
		Usual care	Self-care behavior: 108 ± 22 Total QoL: 28 ± 27 6-minute walk test (feet): 983 ± 299 NYHA FC: 3 ± 1.01	
Barth (2001)[68]	The Minnesota Living With Heart Failure Questionnaire (LHFQ)	Nurse telephone monitoring	Emotional: 50.9 ± 16.3 Physical: 24.4 ± 7.2 Total: 50.9 ± 16.3	There was no statistically significant difference for LHFQ scores between groups.
		Usual care	Emotional: 49.7 ± 15.2, ns Physical: 26.6 ± 8.5, ns Total: 49.7 ± 15.2, ns	
Benatar (2003)[49]	The 21-item Minnesota Living with Heart Failure Questionnaire (MLHFQ); Index-Cardiac Version IV; Heart Failure Self-Efficacy; Hospital Anxiety and Depression Score	Nurse telemenagement	MLHFQ: 51.64 ± 17.36 Index-Cardiac Version IV: 20.93 ± 3.35 Heart Failure Self-Efficacy: 35.90 ± 2.73 Hospital Anxiety and Depression Score: 12.53 ± 5.08	There were no significant differences for QoL between treatments except the Hospital Anxiety and Depression Score was significantly lower in the nurse telemenagement group.
		Home nurse visit	MLHFQ: 57.72 ± 16.24, NS Index-Cardiac Version IV: 18.34 ± 3.73, NS Heart Failure Self-Efficacy: 32.74 ± 3.53, NS	

Study	Quality of life			
	Instrument used	Treatment	Data	Conclusion
			Hospital Anxiety and Depression Score: 15.52 ± 5.97, p=0.03	
Bondmass (1999)[50]	The 21-item Minnesota Living with Heart Failure Questionnaire	Before	Data not shown in the study	23% improved from baseline, p<0.003 Mean satisfaction score was >4.47 (highest 5) from 95% of the sample population
		After (transtelephonic monitoring)	Data not shown in the study	
Dunagan (2005)[70]	The SF-12 Health Survey; the 21-item Minnesota Living with Heart Failure Questionnaire (MLHFQ); the Beck Depression Inventory	Telephone monitoring	SF-12: -1.2 ± 13 (physical); 6.3 ± 10 (mental) MLHFQ: 8.6 ± 11.4 (physical); 1.5 ± 6.6 (emotional) Beck Depression Inventory: 1.9 ± 8.4	There were no significant differences between groups for scores on SF-12, MLHFQ or Depression.
		Usual care	SF-12: -2.5 ± 12, NS (physical); 7.6 ± 12.3, NS (mental) MLHFQ: 7.2 ± 12, NS (physical); 2.9 ± 7.1, NS (emotional) Beck Depression Inventory: 2.3 ± 6.0, NS	
GESICA (2005)[73]	The Minnesota Living with Heart Failure Questionnaire	Nurse telephone intervention	General QoL: 30.6, (better, p=0.001) Physical: 11.2 (p=0.007) Emotional: 6.7 (p=0.002)	Patients in the intervention group had a better quality of life than the usual care patients at the end of the study. Significant more patients in the intervention group adhered to the drug treatment than those in the usual care group
		Usual care	General QoL: 35.0 Physical: 12.8 Emotional: 7.9	
Goldberg (2003)[55]	The Minnesota Living with	Home telehealth	MLHF: -27.8 ± 23.8 SF-12 Physical: 6.7 ±	There was no statistically significant

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
	Heart Failure, SF-12 and Health Distress scores		10.4 SF-12 Mental: 5.9 ± 10.6 Health Distress: 4.8 ± 8.7	difference in quality of life between intervention and usual care groups
		Usual care	MLHF: -23.3 ± 26.9, NS SF-12 Physical: 4.3 ± 11.4, NS SF-12 Mental: 5.2 ± 13.2, NS Health Distress: 5.5 ± 8.8, NS	
Heidenreich (1999)[74]	SF-36	Telephone monitoring	Data not shown	There were little change in quality of life measures during the intervention program as compared with baseline
		Usual care	No data were available for usual care group	
Jerant (2001, 2003)[56,102] HTM vs UC	The 21-item Minnesota Living with Heart Failure Questionnaire (MLHFQ); the SF-36 Health Survey; the Reliability and validity of communication skills questionnaire (CSQ)	Video-based home telecare	MLHFQ: 12.2 ± 8.3 (emotional); 21.2 ± 12.4 (physical) SF-36: 44.6 ± 9.9 (mental); 35.1 ± 10.5 (physical) CSQ: 29.8 ± 3.5	Patient self-care adherence, medications, health status, and satisfaction did not significantly differ between groups
		Usual care	MLHFQ: 8.2 ± 8.5, NS (emotional); 16.1 ± 13.6, ns (physical) SF-36: 48.9 ± 9.5, NS (mental); 33.7 ± 15.7, ns (physical) CSQ: 27.8 ± 4.5, NS	
Jerant (2001, 2003)[56,102] NTS vs UC		Telephone calls	MLHFQ: 5.2 ± 7.5 (emotional); 15.8 ± 11.2 (physical) SF-36: 52.7 ± 12.1 (mental); 29.0 ± 9.0 (physical) CSQ: 29.4 ± 3.6	Patient self-care adherence, medications, health status, and satisfaction did not significantly differ between groups

Study	Quality of life			
	Instrument used	Treatment	Data	Conclusion
		Usual care	MLHFQ: 8.2 ± 8.5, NS (emotional); 16.1 ± 13.6, ns (physical) SF-36: 48.9 ± 9.5, NS (mental); 33.7 ± 15.7, ns (physical) CSQ: 27.8 ± 4.5, NS	
LaFramboise et al (2003)[57]	The Barnason Efficacy Scale-Heart Failure (BEES-HF), the Mood Scale, the 6-minute walk test, and the SF-36 Health Survey	Home visits/Health Buddy	Functional status: 627.3 ± 264.2 Physical health: 59.6 ± 44.7 Bodily pain: 62.2 ± 22.8 Vitality: 42.4 ± 19.5 Mental health: 83.2 ± 11.8	There were no group differences for functional status, depression or health-related quality of life
		Health Buddy	Functional status: 723.4 ± 462. Physical health: 58.3 ± 48.3 Bodily pain: 63.8 ± 30.5 Vitality: 41.7 ± 23.1 Mental health: 78.3 ± 20.8	
		Telephonic	Functional status: 633.16 ±434.13 Physical health: 62.5 ± 44.9 Bodily pain: 57.3 ± 24.8 Vitality: 39.0 ± 27.0 Mental health: 72.9 ± 16.2	
		Home visit	Functional status: 604.44 ± 319.9 Physical health: 58.6 ± 44.3 Bodily pain: 68.0 ± 29.4 Vitality: 44.8 ± 29.0 Mental health: 80.0 ± 14.5	
Laramee (2003)[76]	The 5-item instrument for adherence to treatment survey and the 16-item participant survey for patient	Nurse telephone monitoring	Data not shown	Patients in the intervention group adhered to treatment plan better than the usual care group with regard to daily weights, checks for

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
	satisfaction			edema, and low-salt diet and fluid recommendations (P<0.01). Patients in the intervention group were significantly more satisfied with their care in 13 of 16 items than the usual care group (p<0.01)
		Usual care	Data not shown	
de Lusignan (2001)[58]	Quality of Life and Heart Failure Health Status questionnaires	Telemonitoring	Data not shown by reviewers	There were no significant differences in the quality of life and Chronic Heart Failure questionnaire scores between the telemonitored group and the usual cares. Video link over usual telephone lines was not found to be useful by the patients.
		Usual care	Data not shown by reviewers	
Myers (2006)[61]	The SF-36 v.2 Health Survey	Before	Role physical: 27.4 Bodily pain: 39.5 Vitality: 39.9 Social function: 44.8 Mental health: 68.7 There were13 patients (13.5%) from the original 96 patients who withdrew from the study for reasons of "feeling anxious" or "not liking" the telemonitoring procedure or equipment	There were significant improvements in the self-perceived quality of life in terms of role physical, bodily pain, vitality, social function, and mental health.
		After home telemonitoring	Role physical: 35.2, p=0.05 Bodily pain: 29.3, p=0.00 Vitality: 48.8, p=0.00 Social function: 57.3, p=0.01 Mental health: 75.8, p=0.01	

Study	Quality of life			
	Instrument used	Treatment	Data	Conclusion
Quinn (2006)[77]	Visual analog scale	Low-technology monitoring	Data not shown in the study	Quality of life: 3/17 patients considered good to excellent before the intervention and 7/17 patients considered god to excellent after the intervention
		Usual care	Data not shown in the study	No change in quality of life during the time of the study
Riegel (2002)[78]	A survey measuring satisfaction (5 questions addressing current treatment, convenience of health care, patient education, medication schedule, and the care from the physician)	Nurse telephone monitoring	Satisfaction: 22.88 ± 2.85	Patient satisfaction was significantly higher among persons assigned to the intervention group than among those in the usual care group.
		Usual care	Satisfaction: 21.66 ± 3.44, p=0.01	
Riegel (2006)[79]	The Minnesota Living with Heart Failure Questionnaire (MLHFQ), the EQ-5, and the PHQ-9 (for depression)	Telephone case management	MLHFQ: 1.4 ± 3.0 (emotional); 7.5 ± 7.1 (physical) EQ-5D VAS: 73.4 ± 17.4 EQ-5D Index: 0.82 ± 0.20 PHQ-9: 1.5 ± 2.0	No beneficial effect between group was seen in the disease-specific or generic measures of HRQL or in depression
		Usual care	MLHFQ: 1.9 ± 3.3, NS (emotional); 8.1 ± 6.7, NS (physical) EQ-5D: 73.7 ± 17.4, NS EQ-5D Index: 0.78 ± 0.20 PHQ-9: 2.0 ± 2.1, NS	
Roth (2004)[62]	Self-designed questionnaire	Before	Data not shown in the study	There was significant improvement in the quality of life
		After	Data not shown in the	

Study	Quality of life			
	Instrument used	Treatment	Data	Conclusion
		telecardiology	study	
Schofield (2005)[63]	24-item questionnaire developed specifically for this study to measure patient's satisfaction	Before	Data not measured	Compliance patient's satisfaction was high.
		After home telehealth	Compliance was 96% and patient satisfaction was 94%. No patient was disenrolled for failure to use the device properly	
Schwarz (2008)[64]	The Minnesota living with heart failure questionnaire for QoL, the CES-D for depression	Home telemonitoring plus usual care	QoL: 27.4 ± 21.7 Depression: 8.2 ± 11.2 Caregiver mastery: 25.2 ± 3.8 Days to readmission: 40.6 ± 31.3	There were no differences between groups for depressive symptoms, days to readmissions, quality of life, or care giver mastery
		Usual care	QoL: 27.3 ± 21.6, NS Depression: 6.6 ± 6.7, NS Caregiver mastery: 25.8 ± 3.0, NS Days to readmission: 41.2 ± 24.0, NS	
Shah (1998)[80]	Interview for patient acceptance	Before	Data not measured	Patient acceptance of the program was high
		After (Nurse telephone monitoring)	82% of patients rated the program useful or very useful >90% of the patients found the educational material very useful	
Wheeler (2006)[82]	The Minnesota Living With Heart Failure (MLHFQ) questionnaire, the Problem Rating Scale of Outcomes, the Perception of Health Status, and the Quality	Telephone intervention	No significant differences were found on the MLHFQ, the Perception of Health Status, or the Quality of Life scales from the beginning to the end of the study	No comparison available

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
	of Life Scale			
		Usual care	Data not available	
Woodend (2008)[67]	The Minnesota Living with Heart Failure Questionnaire and the SF-36 Health Survey	Home telemonitoring	Data not shown in the study	The quality of life was better in telehome monitored patients with heart failure than in usual care patients on five of the eight SF-36 subscales at 3 months
		Usual care	Data not shown in the study	

NR: not reported;
QoL: quality of life;
NS: not significantly different;
MLHFQ: The 21-item Minnesota Living with Heart Failure Questionnaire
CSQ: Reliability and Validity of Communication Skills Questionnaire
SF-36: The Medical Outcomes Study Short Form 36

APPENDIX 7C: QUALITY OF LIFE (COPD)

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
Bourbeau (2003)[87]	The SGRQ consisting of 76 items grouped in 3 domains: (1) respiratory symptoms, (2) activities, and (3) impact (a measure of disturbance of daily life, social function and well-being). Lower score indicates a better quality of life	Telephone monitoring	Symptoms: 1.8 (-4.2 to 7.8) Activity: 0.6 (-4.2 to 5.3) Impact: -4.7 (-9.5 to 0.01) Total: -2.0 (-5.9 to 1.8)	The impact subscale and total scores were significantly improved compared with baseline in the intervention group, but only impact subscale showed significant difference between treatment groups.
		Usual care	Symptoms: -4.9 (-8.9 to -0.9) Activity: 0.2 (-3.1 to 3.5) Impact: -1.4 (-4.5 to 1.8) Total: -1.5 (-3.9 to 1.0)	
Farrero (2001)[90]	The Chronic Respiratory Questionnaire (for QoL)	Nurse telephone monitoring	Data not shown in the study	There was no difference in quality of life in any of the four domains of the questionnaire between the two groups
		Usual care	Data not shown in the study	
Trappenburg (2008)[85]	The Clinical COPD Questionnaire for health related quality of life	Home telehealth	Symptom: 2.8 ± 1.2 Functional: 2.9 ± 1.3 Mental: 1.6 ± 1.4 Total: 2.6 ± 1.1	No significant changes in Clinical COPD Questionnaire scores were observed at follow-up between groups
		Usual care	Symptom: 3.0 ± 1.2, NS Functional: 3.2 ± 1.5, NS Mental: 1.8 ± 1.5, NS Total: 2.9 ± 1.2, NS	
Vontetsianos (2005) [86]	Chronic respiratory questionnaire for patients' quality	Before	Data not shown in the study	Significant improvement in patients' quality of life of more than

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
	of life and specially designed questionnaire for their satisfaction			28%, and patients' satisfaction rate was 32% better.
		After telemedicine-assisted home support	Data not shown in the study	

APPENDIX 7D: QUALITY OF LIFE (MULTIPLE CHRONIC DISEASES)

Study	Quality of life			
	Instrument used	**Treatment**	**Data**	**Conclusion**
Chumbler (2004) [92]	Instrumental Activities of Daily Living (IADL); Functional Independence Measure (FIM); Mini-Mental State Examination (MMSE)	Home telehealth	IADL: Improved 2.2 points more than the usual care group ($p<0.0001$) FIM: Improved 14.4 points more than the usual care group ($p<0.0001$) for motor independence; Improved 2.7 points more than the usual care group ($p<0.0001$) for cognitive independence; Improved 15.5 points more than the usual care group ($p<0.0001$) for total independence MMSE: No significant difference between groups	Home telehealth improves functional independence in veterans with chronic disease. 98% of respondents indicated that the technology was easy to use, 95% felt that the technology made them feel more secure, and 92% reported that the technology was helpful in managing their chronic conditions.
		Usual care		
Hopp (2006)[95]	Medical Outcomes Study Short-Form 36-item Veterans' version (SF-36V); A previously designed instrument to assess satisfaction	Home telehealth	Physical: 1.56 (95% CI, -3.53, 6.64) Mental: 4.05 (95% CI, -0.40, 8.51) Satisfaction: -1.00 (95% CI, -2.37, 0.38) 71% wanted to continue the equipment	Home telehealth improves mental health status
		Usual care	Physical: 0.64 (95% CI, -3.83, 5.11), NS Mental: -4.11 (95% CI, -12.13, 3.90), p=0.04 Satisfaction: -1.56 ((95% CI, -3.93, 0.82) NS	
Johnston (2000)[96]	12-item Short-Form Health Survey	Home telehealth	Physical: 30.12 ± 7.18 Mental: 32.66 ± 10.3	There were no differences between groups in the quality of life, quality of care or patient satisfaction
		Usual care	Physical: 31.76 ± 7.52, NS Mental: 33.43 ± 10.65, NS	
Kobb (2003)[97]	Medical Outcomes Study Short-Form 36-item Veterans' version (SF-36V)	Home telehealth	Patients demonstrated a positive change in their perceptions of physical health, social functioning, and mental health with no	Home telehealth improves quality of life as compared to baseline

Study	Quality of life			
	Instrument used	Treatment	Data	Conclusion
			decline in perception about bodily pain, vitality, or emotional status (shown in figure) Patients: 96% thought technology helped them stay healthy, 95% felt comfortable with staff monitoring, 97% would recommend this project to others Providers: 98% thought communication was timely/appropriate, 100% believed the project was a benefit to patients, 100% would refer patients to this project	
		Usual care	Data not shown	
Noel (2004)[98]	The OARS Multidimensional Functional Assessment	Home telehealth	General health: 82.47 ± 12.89 Cognitive status: 19.70 ± 1.06 Functional status: 37.91 ± 9.22 Satisfaction: 106.38 ± 20.99	There were no differences between groups for functional levels and patient rated health status at 6 months.
		Usual care	General health: 85.14 ± 16.28, NS Cognitive status: 19.68 ± 0.69, NS Functional status: 40.49 ± 5.81, NS Satisfaction: 97.14 ± 18.22, p=0.02	

APPENDIX 8A: ASSESSMENT OF ECONOMIC STUDY QUALITY: QUALITY CRITERIA AND EXPLANATION FOR SCORING

Q1	Was an appropriate question posed in an appropriate manner?	Study should have a specific objective which relates to what was actually done
Q2	Is the study perspective appropriate?	Home telehealth can have a financial impact on patients - therefore a study should either be from the societal perspective or should give a justification for why patient costs are not included such as costs would be similar with and without home telehealth
Q3	Is the methodology of high quality?	Study should be based on an RCT or good quality observational study such as a before or after or case usual care study with similar study populations
Q4	Is the methodology appropriate?	Study should involve a formal synthesis of costs and outcomes (clinical and/or quality of life) such as a cost effectiveness or cost utility analysis unless an explicit statement that outcomes are identical
Q5	Is the comparator appropriate?	Study should compare current practice to current practice augmented with home telehealth
Q6	Is the quality of the medical evidence appropriate??	Study should compare outcomes with and without home telehealth – simply assuming that outcomes are the same is not acceptable
Q7	Are appropriate costs considered	All resources must be identified, measured and a unit cost obtained.
Q8	Is discounting conducted?	Most telehealth studies are done over a short time horizon which would normally preclude the need for discounting – however the equipment used has a longer life time and the costs for these must be amortized or lease/rental values used
Q9	Is marginal analysis conducted?	Study should address the issue that the cost of home telehealth will be dependent on the volume of patients treated
Q10	Is sensitivity analysis performed	Study must contain an explicit sensitivity analysis covering a wide range of parameters

APPENDIX 8B: ASSESSMENT OF ECONOMIC STUDY QUALITY: RATIONALE FOR QUESTIONS

Q1: Was an appropriate question posed in an appropriate manner?

For a study to be useful in assisting in decision making it is necessary that the purpose/objective of the study is explicit. Therefore, the study should contain a specific objective which relates to what was actually done and this objective should relate to determining the economic impact of the specific program.

Q2: Is the study perspective appropriate?

An economic evaluation can be conducted from a number of perspectives. Home telehealth can lead to a major financial impact on patients and their families and caregivers. The program can increase the burden on families if the aim is to reduce face to face contact time with health professionals, as this may require some form of shifting of responsibilities from the formal health care system to families. Alternately, home telehealth may be designed to reduce further hospitalizations, which can reduce the costs to patients, their families, and informal caregivers. Given these concerns, a study should either be from the societal perspective (incorporating costs to patients, their families, and caregivers) or should provide an argument for why such costs are not evaluated. A suitable justification would be that such costs would be similar with and without home telehealth.

Q3: Is the methodology of high quality?

For an economic evaluation to be appropriate for aiding decision making, the estimates of incremental costs and effects must come from a valid and reliable source. Estimates of the incremental costs and effects for home telehealth programs must come from a suitable research design which minimizes potential bias. The ideal study design would be a randomized usual careled trial. Observational studies such as before and after or case usual care studies would be appropriate if it can be demonstrated that the study populations for all comparators are similar.

Q4: Is the methodology appropriate?

Economic evaluation involves the formal synthesis of costs and outcomes. Thus studies of home telehealth require an estimate of the incremental costs of a program as well as the incremental effects on outcomes such as clinical endpoints or quality of life. Ideally, studies would be cost effectiveness or cost utility analyses. A cost minimization analysis would be acceptable, but this requires an explicit statement that either outcomes are identical or better for the least costly outcome. Otherwise, studies would only be partial economic evaluations.

Q5: Is the comparator appropriate?

In economic evaluations, new health interventions need to be compared with current practice, in order to assess the incremental costs and effects of their introduction. To assess the cost effectiveness of home telehealth it is necessary that a study assesses the incremental costs and effects of the program compared with current care. Thus, the study should compare current practice to current practice augmented with home telehealth.

Q6: Is the quality of the medical evidence appropriate?

An economic evaluation must involve a formal comparison of costs and outcomes. Many evaluations of home telehealth programs ignore outcomes or assume no change. To allow assessment of whether the incremental costs of home telehealth are worthwhile, the study must compare outcomes with and without home telehealth. Simply assuming that outcomes are the same is not acceptable.

Q7: Are appropriate costs considered?

Within economic evaluations, it is necessary to recognize and include all major resource items. All resources must be identified, measured and a unit cost obtained. For home telehealth this will require recognition of all costs falling on the health and social care systems as well as costs falling on patients and their caregivers. This must include all costs associated with the implementation of the home telehealth program.

Q8: Is discounting conducted?

It is necessary within an economic evaluation to discount costs and effects occurring in the future, to reflect societal time preference. Most telehealth studies are done over a short time horizon which would normally preclude the need for discounting. However, studies must incorporate the costs of equipment which should be allocated over their useful life. These costs must be either amortized or lease/rental values should be used.

Q9: Is marginal analysis conducted?

The costs associated with an intervention can be dependent on the volume of patients treated. This is especially the case with home telehealth programs where the costs of implementation are spread over the number of patients within any program. A study should address this issue by assessing the costs of the program based on different numbers of patients to determine what level of enrollment is required for the program to be worthwhile

Q10: Is sensitivity analysis performed?

The results of an economic evaluation are highly dependent on the assumptions taken within the analysis. It is necessary to assess the robustness of the study's results to changes in assumptions through formal sensitivity analysis.

APPENDIX 9: EXCLUDED ECONOMIC STUDIES

1. CHF managers make the case for home-monitoring technology. *Disease Management Advisor* 2002;8(10):156-8.

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APPENDIX 10: CHARACTERISTICS OF INCLUDED ECONOMIC STUDIES

Heart Failure

Study		Benatar[49]	Bondmass[50]
Country		US	US
Disease area		Heart failure	Heart failure
Patient Population		Patients with documented HF	Patients with documented HF
Comparators	Current	Home health care delivered primarily by home nurse visits (n=108)	Home health care delivered primarily by home nurse visits (n=60)
	Home telehealth	Home health care delivered primarily by nurse telemanagement (n=108)	Home health care delivered primarily by nurse telemanagement (n=60)
Form of analysis		Cost analysis	Cost analysis
Resources included		Telemanagement equipment and staff time, heart failure related hospitalizations	Telemanagement equipment and staff time, heart failure related hospitalizations
Perspective		Insurance provider	Insurance provider
Study design		Randomized usual careled trial	Before and after study
Time horizon		3 months	1 year
Study results		Hospitalization charges were substantially lower for the telemanagement group – a saving of approximately $1,000 per patient. QoL was similar across treatments. The telemanagement program cost $2.87 per day	Hospitalization charges were substantially lower during the period of the intervention compared to the prior period. It is not possible to derive the cost of the telemanagement program from the study.
Comments		The telemanagement program is likely to be cost saving, though the study only included the costs of HF-related hospitalizations and not other health care resources.	Study is a pilot study for the study by Benatar[49] and has the same limitations.
Study Quality		5 out of 10 items	2 out of 10 items

Study		Galbreath[71]	Heidenreich[74]
Country		US	US
Disease area		Heart Failure	Heart failure
Patient Population		Patients with symptomatic CHF and documented systolic and diastolic dysfunction	Patients with documented HF
Comparators	Current	Managed as usual by their primary care physician	Care prior to enrollment to program (n=68)
	Home telehealth	Initially weekly transitioning to monthly telephone calls from nurse disease manager focused on symptom monitoring and management, education, and treatment recommendations forwarded to family physicians.	Patients were provided an automated blood pressure cuff with a digital scale. Each day, patients phoned in their blood pressure, pulse, weight, and symptoms. A nurse was paged if data were a concern and the patients could contact their physician if required (n=68)
Form of analysis		Cost analysis	Cost analysis
Resources included		Emergency room visits, hospitalizations, laboratory costs, and physician visits.	Total health care claims (excluding costs of the telehomecare program)
Perspective		Healthcare system	Insurance provider
Study design		Randomized usual careled trial	Before and after study
Time horizon		18 months	1 year
Study results		The total costs for each six month period ranged from $3,001.26 to $3,711.65 in the usual care group and from $2,919.38 to $3,602.67 in the intervention group. There were no significant differences between the two groups with respect to costs.	Medical claims were lower than in the year prior to enrollment in the program whilst for the usual care group costs increased over the same period.
Comments		Even without taking into consideration the costs of the intervention the results did not support cost savings with home telehealth.	The study did not assess clinical outcomes nor include the costs of the telehomecare program. Given the design, it is not possible to derive a strong conclusion from the study.
Study Quality		5 out of 10 items	2 out of 10 items

Study		Jerrant[102]	Laramee[76]
Country		US	US
Disease area		Heart failure	Heart failure
Patient Population		Patients aged ≥40 with a primary hospital admission for CHF	Patients discharged from hospital with primary or secondary diagnosis of CHF, left ventricular dysfunction of less than 40%, or evidence of pulmonary edema which required diuresis.
Comparators	Current	Usual outpatient care as directed by their primary care physician (n=13)	Usual care as determined by local family physician. (n=146)
	Home telehealth	Two interventions: Telephone care: scheduled phone calls from a nurse with access to nurse 8-5, Monday to Friday (n=12) Video based telecare: scheduled telecare visits from a nurse with access to nurse 8-5, Monday to Friday (n=12)	Early discharge planning, patient and family CHF education, 12 weeks of telephone follow-up and promotion of optimal CHF medications. (n=141)
Form of analysis		Cost analysis	Cost analysis
Resources included		CHF related admissions	Hospitalizations, outpatient costs including primary care and cardiologist visits, and home healthcare costs.
Perspective		Insurance provider	Healthcare system
Study design		Randomized usual careled trial	Randomised usual careled trial
Time horizon		6 months	90 day follow-up
Study results		Costs of CHF related admission and frequency of emergency visits were lower in the video based telecare group and the telephone care group compared to the usual care group.	Although not statistically significant, the overall costs in the intervention were lower than those in the usual care group ($23,054 vs. $25,536).
Comments		Both telephone care and video based telecare appear to reduce health care costs though not all costs were included in the analysis and the study sample size (n=37) limits the conclusions that can be drawn. Video based care may not provide additional benefits to telephone based care.	The cost of the intervention, an average of $228.52 was not included in the overall cost comparison. The telehealth intervention did not have a significant effect on readmission rates.
Study Quality		4 out of 10 items	5 out of 10 items
Study		Myers[61]	Nobel[131]
Country		US	US
Disease area		Heart failure	Heart failure

Patient Population		Patients with class III or IV CHF, recently discharged from hospital	Patients with severe CHF
Comparators	Current	Traditional home health care (n=83)	Support program to reinforce careful attention to medications and diet
	Home telehealth	Home monitoring involving patients transmitting data on vital signs and weight to a nurse daily and the nurse phoning the patient to advise on medication modification or the need for referral to other health care (n=83)	Above with daily home based biometric monitoring looking at weight and symptoms. Results were forwarded to a nurse and if results suggested clinical deterioration, the patient's physician contacted them to advise that they seek further care
Form of analysis		Cost analysis	Cost analysis
Resources included		Home visits, hospitalizations, emergency department visits, telemonitoring equipment, telemonitor nurse	Health care claims
Perspective		Insurance provider	Insurance provider
Study design		Case usual care study	Case usual care study
Time horizon		2 months	12 months
Study results		Telemonitoring reduced the frequency of home visits and led to savings of $189 per patient over a two month period.	Telemonitoring led to a 60% reduction in health care costs from the previous year compared to a 16% reduction in the usual care group.
Comments		Telemonitoring appeared to reduce health care resource use. However, the study was not randomized and differences may be due to differences in the patient populations.	Study did not give details of what resource items were affected by telemonitoring and did not include the costs of the monitoring program. Details of patient characteristics and study sample size for the usual care and intervention populations are not given.
Study Quality		5 out of 10 items	1 out of 10 items

Study		Riegel[79]	Riegel[78]
Country		US	US
Disease area		Heart failure	Heart failure
Patient Population		Hispanic patients admitted to hospital with CHF	Patients admitted to hospital with clinical diagnosis of HF
Comparators	Current	Usual care with patients educated about CHF management (n=65)	Patients educated about CHF management prior to discharge (n=228)
	Home telehealth	Telephone case management with nurses directed to examine factors linked to CHF hospitalization. Emphasis on education and monitoring, not on changing medications or follow up care (n=69)	Telephone case management with nurses directed to examine factors linked to CHF hospitalization. Patients contacted 5 days after discharge and followed based on symptoms, knowledge and needs (n=130)
Form of analysis		Cost analysis	Cost analysis
Resources included		Hospitalizations	Hospitalizations, nurse training and nurse contact
Perspective		Insurance provider	Insurance provider
Study design		Randomized usual careled trial	Randomized usual careled trial
Time horizon		6 months	6 months
Study results		At six months, telephone case management led to lower all cause inpatient costs per patient ($10,015 versus $13,967) and lower CHF related inpatient costs ($5,567 versus $6,151). Neither difference was statistically significant. No difference in quality of life was found.	Telephone case management led to lower CHF related inpatient costs at six months for the intervention group ($1,192 versus $2,186). Patients on the program reported less physician office visits but more emergency department visits though differences were not statistically significant. The program costs $443 per patient for six months.
Comments		Results suggest that telephone case management may lower hospitalization costs though the findings are limited by the study sample size and the failure to include the costs of the program.	Results suggest that telephone case management may lower hospitalization costs though the findings are limited by the study sample size and the failure to include the costs of the program.
Study Quality		4 out of 10 items	6 out of 10 items

Study		Southard[130]	Vacarro[66]
Country		US	US
Disease area		Heart failure	Heart failure
Patient Population		Patients ranging from 37 to 86 years with either CHF or coronary heart disease.	Patients with moderate to severe HF who were admitted in the previous year or who had three emergency department visits
Comparators	Current	Usual care (n=51)	Previous health care (n=638)
	Home telehealth	Internet program which was accessed for at least 30 minutes per week and included interaction with a nurse case manager and dietician, educational programs, a discussion group and small rewards for participation (n=53)	Patients provided a Health Buddy which is a device which directs patients to monitor symptoms and provides education. Results are sent to a case manager and relevant patients are assessed for further care (n=52)
Form of analysis		Cost analysis	Cost analysis
Resources included		Cost of intervention including staffing, overhead and subscription, emergency room visits, and hospitalizations.	Hospitalizations, emergency department visits
Perspective		Health care system	Insurance provider
Study design		Randomized usual careled trial	Case usual care study
Time horizon		6 months	6 months
Study results		A Net cost savings of $965 was calculated for the intervention group including the costs of the intervention. There were also fewer cardiovascular events within the intervention group (4.1%) as compared with the usual care group (15.7%) (p=0.053).	The telehealth program led to annual cost savings in terms of hospitalizations and emergency department visits per patient of $5,271. This would offset the costs of the program.
Comments		An internet based homecare system appeared to be a cost effective intervention for secondary prevention in cardiovascular patients.	The program appears to be cost saving though details of the costs of the program are not provided. Health outcomes are not reported.
Study Quality		6 out of 10 items	2 out of 10 items

Diabetes

Study		Biermann[23]	Chase[25]
Country		Germany	US
Disease area		Diabetes	Diabetes
Patient Population		Diabetics on intensified insulin therapy (at least four insulin injections daily)	Adolescents aged 15 to 20 years with type 1 diabetes.
Comparators	Current	Usual care which consisted of clinic visits every 3 months. (n=33)	A structured diabetes education program involving self usual care of blood glucose with monitoring of insulin dose (n=16)
	Home telehealth	Transmission of blood glucose every 2 weeks to a nurse or physician who phoned the patient with treatment advice in addition to 6 month clinic visits. (n=30)	Above except information on blood glucose levels was sent to diabetes centres through mode with advice on dose adjustment being provided through telephone communication (n=17)
Form of analysis		Cost analysis	Cost analysis
Resources included		Modem lease, phone consultations, data transfer, travel, lost earnings	Clinic visits, healthcare professional salaries, patient costs including travel, meals babysitting, and intervention equipment.
Perspective		Societal	Societal
Study design		Randomized usual careled trial	Randomized usual careled trial
Time horizon		8 months	6 months
Study results		Telemanagement led to cost savings of approximately 648 Euro per patient from the societal perspective. From the health care perspective, telemanagement had an associated incremental cost of 218 Euro	The average cost per patient in the usual care group was $305 as compared with $163 in the intervention group. Diabetes usual care and the incidence of acute diabetes related complications were comparable between the 2 groups.
Comments		Differences in clinical outcomes were not adequately assessed within this study. Whether telemanagement can be considered cost saving is dependent on the perspective adopted by decision makers. However, the costs of insulin therapy and other health care costs such as physician visits were not included in the analysis.	Biweekly communication of blood glucose, healthcare provider telephone follow up and 6 month clinic visits appear to be a cost effective alternative to 3 monthly clinic visits.
Study Quality		6 out of 10 items	9 out of 10 items

Study		Cherry[133]	Dansky[134]
Country		US	US
Disease area		Diabetes	Diabetes
Patient Population		Indigent or economically disadvantaged Mexican border residents with diabetes	Elderly diabetic patients recently discharged from hospital
Comparators	Current	Usual care for a sample of patients one year prior to start of study. (n=169)	Skilled nursing home visits post discharge (n=85)
	Home telehealth	Patients are given a Health Hero iCare Desktop and a Health Buddy, which helps the patient manage their disease through monitoring, education , reinforcement, prompts to action, and interaction with a nurse case manager. (n=unknown)	Skilled nursing home visits post discharge plus video visits through a patient station incorporating a camera, and medical sensors with telephone contact (n=86)
Form of analysis		Cost analysis	Cost analysis
Resources included		Healthcare services	Staff time for video visits (including training), equipment, administrative costs, home visits, hospitalizations
Perspective		Healthcare system	Health care system
Study design		Before and after	Randomized usual careled trial
Time horizon		1 year	60 days
Study results		There was an inflation adjusted reduction in average healthcare service costs per patient of $747 per year during the telehealth intervention.	Home telehealth involves additional costs that can be offset by reduction in the use of home visits and the need for hospitalization
Comments		Study did not include the cost of the intervention. After 1 year of the telehealth intervention there was a significant reduction in both inpatient and outpatient service utilization.	The study did not report clinical outcomes. It is difficult to interpret the cost savings from home telehealth as the annual costs of the program are calculated whilst the comparison between programs for the costs of home care are calculated per patient episode and are based on hypothetical data
Study Quality		2 out of 10 items	7 out of 10 items

Study		Mason[128]
Country		UK
Disease area		Diabetes
Patient Population		Patients with type 2 diabetes
Comparators	Current	Usual care (not defined) (n=300)
	Home telehealth	Call station managed by trained telecarers (not nurses) who called patients relating to education, medication adherence and blood glucose usual care (n=394)
Form of analysis		Cost utility analysis
Resources included		Administration, space, staff salaries, training and computer terminals.
Perspective		Unknown
Study design		Randomized usual careled trial
Time horizon		1 year
Study results		Telecare program cost £43,400 per QALY gained under trial conditions and £33,700 assuming routine use
Comments		The utilities and costs outside of the program were drawn from a previous US study which was then transformed to the UK setting. There were no allowances for differences in populations. Details of other resources included were not given. Study concluded the program was currently not cost effective
Study Quality		9 out of 10 items

COPD

Study		Farrero[90]	Maiolo[127]
Country		Spain	Italy
Disease area		COPD	Various respiratory diseases including COPD
Patient Population		Patients with COPD requiring long-term oxygen	Patients with severe respiratory failure who require long-term oxygen therapy
Comparators	Current	Usual care as directed by patient's chest and family physician (n=62)	Usual face to face care with hospital visits every 3 months (n=30)
	Home telehealth	Monthly telephone call and 3 month home visit performed by a nurse focused on symptom assessment, spirometry and evaluation of oxygen therapy. Patients also have on demand access. (n=62)	Twice weekly home oximetry monitoring with telephone follow up by respiratory physicians in addition to 3 month hospital visits. (n=30)
Form of analysis		Cost analysis	Cost analysis
Resources included		Hospitalizations and intervention costs	Hospitalizations and intervention costs
Perspective		Healthcare system	Healthcare system
Study design		Randomized usual careled trial	Before and after study
Time horizon		1 year	12 months
Study results		At 1 year the total costs for the intervention group were 15.8 million pesetas including the 6.7 million pesetas cost of the intervention as compared with 24.0 million pesetas for the usual care group, a cost savings of 8.2 million pesetas. No difference in QoL was found.	Cost of hospitalizations during usual care phase was 233,000 Euros versus 133,000 Euros in the intervention phase. After incorporating the 60,000 Euro cost of the telemedicine service there was a net savings of 40,000 Euros in the intervention group.
Comments		Results suggest that telephone and home visit case management may lower hospitalization costs though the findings are limited by the study sample size.	Results suggest that home telemonitoring may lower hospitalization costs although the findings are limited by the sample size.
Study Quality		7 out of the 10 items	5 out of 10 items

Study		Paré[129]
Country		Canada
Disease area		COPD
Patient Population		Patients with severe COPD discharged from first hospitalization, requiring frequent home visits
Comparators	Current	Home care with personalized patient based management of medications (n=10)
	Home telehealth	Usual care plus a webphone for monitoring measures of health to both assist patients in monitoring their own health and to allow staff to send advice (n=19)
Form of analysis		Cost analysis
Resources included		Nursing costs, travel costs, hospitalizations, device costs
Perspective		Health care system
Study design		Case usual care study
Time horizon		6 month
Study results		The costs of the telehomecare program were primarily offset by reductions in further hospitalizations leading to a cost saving per person of $355 per patient
Comments		Study incorporated all appropriate costs to the health care system and presented a reasonable argument that patient costs would not be higher for telehomecare patients. The study did not measure outcomes, though the reduction in hospitalizations with telehomecare suggest no worse outcomes.
Study Quality		6 out of 10 items

Multiple diseases

Study		Johnston[96]	Noel[135]
Country		US	US
Disease area		Multiple diseases: including CHF, diabetes and COPD	Multiple diseases: including CHF, diabetes and COPD
Patient Population		Patients diagnosed with CHF, COPD, diabetes, cerebrovascular events, cancer or requiring wound care	Patients with at least three or more chronic or complex conditions who have been receiving home care for at least six months
Comparators	Current	Routine home health care with access to nurse by telephone (n=110)	Nurse case management as prior to the study (n=9)
	Home telehealth	Video visits in addition to telephone and in person visits. Video access available 24 hours a day (n=102)	Nurse case management plus 24 hour telemonitoring for 3 months – monitoring involved the transmission over regular phone lines of physiological data (n=10)
Form of analysis		Cost analysis	Cost analysis
Resources included		Physician visits, emergency department visits, hospital services (not hospitalizations), home health care	Unclear
Perspective		Health care system	Insurance provider
Study design		Randomized usual careled trial	Randomized usual careled trial
Time horizon		Not specified	6 months
Study results		Costs per patient in the video care group were greater for home telehealth ($1,830 versus $1,167) and less for other health care resources ($1,948 versus $2,674)	No significant differences in costs or quality of life between the usual care and intervention arm of the trial.
Comments		There were no significant differences in costs between the groups. The study did not have a specified time horizon and it is difficult to assess whether differences in duration were usual careled for in the analysis of costs. The study did not report clinical outcomes	Study is difficult to review as there is a lack of transparency regarding which costs are included. The study is small which makes finding differences between groups difficult. Study compares the intervention to usual care and the intervention to both a before and after period which makes interpretation difficult
Study Quality		4 out of 10 items	4 out of 10 items

APPENDIX 11: QUALITY ASSESSMENT OF INCLUDED ECONOMIC STUDIES

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Benatar [49]	✓		✓	✓	✓	✓				
Bondmass [50]	✓				✓					
Galbreath [71]	✓		✓	✓	✓	✓				
Heidenreich [74]	✓				✓					
Jerant [102]	✓		✓		✓		✓			
Laramee [76]	✓		✓		✓		✓	✓		
Myers [61]	✓		✓		✓		✓		✓	
Nobel [131]					✓					
Riegel [79]	✓		✓		✓	✓				
Riegel [78]	✓		✓	✓	✓	✓			✓	
Southard [337]	✓		✓	✓	✓	✓	✓			
Vaccaro [66]	✓				✓					
Biermann [23]		✓	✓		✓	✓	✓	✓		
Chase [25]	✓	✓	✓	✓	✓	✓	✓	✓		✓
Cherry [133]	✓				✓					
Dansky [134]	✓		✓		✓		✓	✓	✓	✓
Mason [128]	✓		✓	✓	✓	✓	✓	✓	✓	✓
Farrero [90]	✓		✓	✓	✓	✓	✓	✓		
Maiolo [127]	✓		✓	✓	✓	✓				
Pare [129]	✓	✓	✓		✓		✓	✓		
Johnston [338]	✓		✓		✓			✓		
Noel [135]	✓		✓		✓	✓				

APPENDIX 12: REVIEW OF NON-PEER REVIEWED CANADIAN REPORTS

An Evaluation of the Telehomecare Demonstrator Project: EMPcare@home[20]

The EMPcare@home project was a pilot project within New Brunswick to evaluate a disease management approach involving home telehealth, with a focus on patients with heart failure or COPD. The project incorporated telephone monitoring of patients with a major educational component. The objectives included reduction in both emergency department visits and readmission rates by 10%. The evaluation would not have been considered appropriate for the economic review, as there was no costing of the health care resources used.

Analysis examined the use of emergency room visits and readmissions for three groups: the telehomecare group based in Woodstock (n=85), a usual care group from Woodstock (n=121), and a usual care group from Perth-Andover (n=91). Analysis focused on three time periods: the period three months prior to implementation of the telehomecare project, the three months of the telehomecare project, and the three months post project.

The reduction in readmissions during the period of the project was 23% higher for the group receiving EMPcare@home than the Perth Andover group, and this was maintained during the following three months. The reduction in emergency room visits during the period of the project was 4% higher for the group receiving EMPcare@home than the Perth Andover group, and this increased to 8% during the following three months.

The major limitation of the EMPcare@home study is the comparability of the usual care group with the main intervention group. The investigators attempted to compensate for this by including a before and after analysis in addition to the case usual care in order to limit this weakness, but acknowledge that it is not possible to directly attribute any reductions in services to the pilot project.

A further limitation is that the study focused solely on the use of emergency visits and readmissions, and did not measure health care costs or the costs of the EMPcare@home system, and failed to include costs of family physician visits, pharmaceuticals, and costs to patients.

CANARIE E-health Program: East York Telehomecare Project[339]

The East York Telehomecare Project involved a video based home telehealth strategy whereby visits with patients were conducted through videoconferences conducted using telephone lines. The evaluation would not have been considered appropriate for the economic review as there was no comparator.

Twenty seven patients were recruited in the first year of the project which was less than the projected 50. Patients had chronic illnesses such as COPD, heart failure and diabetes.

A preliminary evaluation found that there were no savings during the first period of the project although the investigators state that there is the potential for savings to be realized in the future due to limited used of patient admissions (none during the assessment period) and ED visits (only 1 visit).

The study has a major limitation in that there is no obvious comparator group to assess the incremental effect of home telehealth on resource use and clinical outcomes. As such the study can be seen primarily as a feasibility study rather than an evaluation.

Canada Health Infoway: Home Telehealth Business Case Report[3]

This business case report was prepared for the Canada Health Infoway and relates to a generic home telehealth program. It relates to home telehealth for chronic disease management, and assumes monitoring of vital signs and transmission of data health care providers. Five potential intervention areas are considered: COPD, HF, diabetes, post surgery, and wound care. This report would not be considered within the economic review, as it does not relate to actual strategies of patient management, but rather to hypothetical models which are not well described.

The analysis takes available data on resource use for specific patient groups and then assumes a reduction in those resources based on data from other published studies. The analysis uses many of the studies included in the economic review (e.g.,[129,134]) as the source for the potential reduction in services. The study concludes that a home telehealth program would lead to substantial cost savings in all areas.

The major limitation of this report is that it is not an evaluation of an actual home telehealth program, rather it is a hypothetical analysis based on broad assumptions relating to current use of resources and the impact of home telehealth. The study does not address the underlying limitations of the studies used to estimate any cost savings, nor does the study address the appropriateness of using data from studies not relating to the Canadian health care system as a basis for estimating such cost savings.

APPENDIX 13A: DIRECT COST ITEMS

Item	Unit Price*	Cost Source
Emergency department visit[1]	52.16	EMPcare@home[20]
Inpatient day[1]	451.06	EMPcare@home[20]
Hours (Nurse Compensation)[2]	36.02	EMPcare@home[20]
Visits (Non-compensation)[3]	31.59	EMPcare@home[20]
Physician visits	Outpatient visits not reported	
Education materials	Not reported	
Sentry Monitor (includes heart rate, blood pressure, pulse oximetry, temperature and weight)	8,940†&	Mike Benjamin, Honeywell HomeMed, Brookfield, WI, USA: personal communication: Jul 2008
Sentry Central Station	9,120	Mike Benjamin, Honeywell HomeMed, Brookfield, WI, USA: personal communication: Jul 2008
Genesis Monitor inludes Heart Rate, Blood Pressure and Weight		
Genesis	3,780	Mike Benjamin, Honeywell HomeMed, Brookfield, WI, USA: personal communication: Jul 2008
Genesis including Finger Probe with Oximeter Assembly	4,200	Mike Benjamin, Honeywell HomeMed, Brookfield, WI, USA: personal communication: Jul 2008
Lifescan One Touch Basic	Cost of test strips = 48.02 for a box of 50	ECRI[340]
Lifescan One Touch Profile	122.91	ECRI[341]
Roche Accu-Chek Advantage	64.66	ECRI[341]

Item	Unit Price*	Cost Source
PiKo-1 (Pulmonary Data Services)	38.11	QuickMedical[342]
ecg@home (HealthFrontier for Honeywell HomMed)[343]		
ecg@home Hardware	376.68	Health Frontier[343]
ecg@home Accessories		
ecg@home Dual patient cable	35.65	Health Frontier[343]
ecg@home External electrode	25.45	Health Frontier[343]
K2 Electrode Solution 15ml tube bottle K2 Solution	5.05	Health Frontier[343]
USB serial adapter	70.33	Health Frontier[343]
TeleVyou videophone		Price not found
Oracle license for standard edition one	152	CDW Product Overview[344]
HP ProLiant DL360 rack mounted server	2,155	HP Canada[345]

* 2008 Canadian dollars

1. The unit costs for an emergency visit and inpatient care costs were calculated using the Management Information System (MIS) reporting of River Valley Health for the Woodstock hospital. They include variable costs but not fixed costs since they would not be impacted by the telehomecare intervention.

2. Refers to all health professional staff directly involved in the provision of care for the patients receiving telehomecare. Staff travel time is not included.

3. The average non-labour costs per patient visit (e.g. car leasing and maintenance costs).

† Volume discount pricing are negotiated for orders in excess of 50 monitors.

& Price includes 5 years of 1-800 support, technology software upgrades and warranty.

§ Internet price is the base price for online purchases direct from HP Canada. Product currently not sold online may be purchased from a HP authorized retailer. In this case, Internet price is a suggested resale price.

APPENDIX 13B: HEALTH SERVICES UTILIZATION[20]

	Woodstock telehomecare					Woodstock usual care				
	N	Pre 0-3 months[1]	Post 0-3 months[2]	N	Post 4-6 months[3]	N	Pre 0-3 months	Post 0-3 months	N	Post 4-6 months
Mean annualized rate in hospital admissions for any condition	85	3.44	1.27	71	0.96	121	2.64	1.72	114	2.67
Mean annualized rate in hospital admissions due to CHF and/or COPD	79	1.67	0.61	62	0.26	116	0.97	0.59	109	0.44
Mean annualized rate emergency for any condition	85	7.20	4.42	71	3.04	121	6.78	5.09	114	4.32

1. Three-month period before enrolment (when the home monitors were in the patients' home)

2. Subsequent three-month period (i.e., 0 to 3 months after enrolment)

3. Subsequent three-month period after the monitors were removed (i.e., 4 to 6 months after enrolment)

APPENDIX 13C: EMP CARE[20]

	EMP Care							
	N	Post 0-3 months[1]	N	Post 4-6 months[2]	N	Post 0-3 months	N	Post 4-6 months
Mean number of total EMP staff hours spent per patient [3]	54	17.40	40	5.03	121	10.51	114	6.40
Mean number of in-person EMP visits	54	11.33	40	4.95	121	10.02	114	6.00
Mean number of EMP telephone calls	54	15.87	40	3.05	121	3.46	114	2.49
Mean number of instances of other EMP work	54	29.04	40	3.75	121	7.23	114	4.70

1. Three-month period before enrolment

2. Subsequent three-month period after the monitors were removed (i.e., 4 to 6 months after enrolment)

3. Total EMP staff hours are composed of hours spent on in-person visits, telephone calls with patients and other work, such as the work of base station nurse, reviewing and discussing patient home monitoring data, recording information in charts, contacting the family physician, etc. It does not include travel time on a patient-specific basis

APPENDIX 13D: TOTAL UNADJUSTED ANNUAL DIRECT COST BY GROUP

Cost Category	Woodstock Telehomecare ($) (n=85)	Woodstock Usual Care ($) (n=121)
Variable Costs		
Inpatient care (all conditions)[1]	433,243	1,184,341
Emergency department visit (all conditions)[1]	7,057	12,459
EMP Staff compensation[2]	27,157	32,645
Physician services (utilization data not reported)		
Medication costs (utilization data not reported)		
Sentry Monitor	759,900	0
USB serial adapter	5,978	0
Peripherals (utilization data not reported)		
Total Variable Costs†	1,233,335	1,229,445
Total Variable Costs per Patient§	14,510	10,161
Fixed Costs		
Sentry Central Station	9,120	0
HP ProLiant DL360 rack mounted server	2,155	0
Oracle database license-	n=20	

Cost Category	Woodstock Telehomecare ($) (n=85)	Woodstock Usual Care ($) (n=121)
Standard edition one	3,040	0
Total Fixed Costs*	14,315	0
TOTAL COST**	1,247,650	1,229,445
TOTAL COST PER PATIENT***	14,678	10,161

† Total variable costs = Sum of unit price for each item in variable cost category X utilization of item by group

§ Total Variable Costs per Patient = Total variable costs /number of patients in group

* Total fixed costs = Sum of unit price for each item in fixed cost category X utilization of item by group

** Total cost = Total variable costs + total fixed costs

*** Total cost per patient = Total cost per category/number of patients in group

1. A weighted average of the mean annualized hospital admission and emergency room rates were calculated based on the rates in post 0-3 and 4-6 months in order to calculate the cost for inpatient care and emergency room visits.

2. The mean number of total EMP staff hours spent per patient in post 4-6 months were extrapolated to nine months in order to calculate the annualized mean number of total EMP staff hours spent per patient. Subsequently, the total cost for EMP staff hours were calculated based on the results for post 0-3 months and post 4-6 months extrapolated to nine months.

APPENDIX 13E: SENSITIVITY ANALYSES RESULTS

Sensitivity Analysis	Woodstock Telehomecare ($) (n=85)		Woodstock Usual Care ($) (n=121)	
	Total cost	Total cost/patient	Total cost	Total cost/patient
Inpatient care (all conditions)				
Minimum LOS stay (1 day)	857,731	10,091	163,539	1,352
Maximum LOS stay (111 days)[1]	5,623,601	66,160	13,191,369	109,020
Volume discount pricing for Sentry monitor[2]				
25% discount	1,057,870	12,446	1,229,445	10,161
50% discount	867,895	10,210	1,229,445	10,161

1. Maximum LOS was based on the weighted average LOS for ICD-10 codes, I50.0, J44.0 and J44.1.

2. The volume discount pricing for Sentry monitor does not apply to the Woodstock Usual Care group, so the total costs remained unchanged from the base case scenario.

APPENDIX 14: HOME TELEHEALTH TECHNOLOGIES AVAILABLE IN CANADA FOR CHRONIC DISEASE MANAGEMENT

Manufacturer Name and Contact Information	Devices
AMD Telemedicine 73 Princeton Street North Chelmsford, MA, USA 01863 Phone: (978) 937-9021 or 1-866-511-1301 Fax: (978) 937-5249 Web site: http://www.amdtelemedicine.com	**CareCompanion** -Self-contained home unit prompts patient to take medication and answers questions. Medical peripherals can be added to collect patient data related to specific health needs and send data to the CareCompanion Server. Video speakerphone can also be added.
American TeleCare 15159 Technology Drive Eden Prairie, MN, USA 55344 Phone: (952) 897-0000 or 1-800-323-6667 Fax: (952) 944-2247 Email: info@americantelecare.com Web site: http://www.americantelecare.com/	**Aviva 200 LifeView System** -Patient monitor with interactive video, moveable camera, and various medical peripherals. **Aviva 200 inLife XP System** - Patient monitor utilizing a PC, with various medical peripherals.
AudiSoft Technologies Inc. 1470-B Joliot-Curie Boucherville, Quebec J4B7L9 Phone: 1-877-641-8436 Fax: (450) 641-3659 E-mail: info@audisoft.net Web: http://www.audisoft.net/en/index.htm	**Frontline Communicator** -Wireless, compact video-communication system, specifically developed for remote support and distance training.
Brytech Inc. 2301 St. Laurent Blvd., Suite 400 Ottawa ON K1G 4J7 Phone: (613) 731-5800 Fax: (613) 731-5812 Email: inquiries@brytech.com Web: http://www.brytech.com/medical/index.htm	**Brytech RPM** -Wireless patient monitoring system, designed for ambulatory patients in hospital with future applications for home telehealth planned.
Honeywell International Inc. 101 Columbia Road Morristown, NJ USA 07962 Phone: (973) 455-2000 Fax: (973) 455-4807 Web: http://www.honeywell.com	**Honeywell HomMed Sentry** -Suite of interoperable products; Genesis Telehealth Monitor for monitoring vital signs: ECG, pulse oximetry, blood pressure, pulse rate, temporal thermometer, and weight; Data transferred by modem, pager, or landline. Central Station – Diagnostic Software for Managing Patient Care; Telehealth Monitor Peripherals
IgeaCare Systems Inc.	**Health@nywhere**

91 Granton Drive Richmond Hill, ON L4B-2N5 Phone: (905) 707-1669 or 1-866-361-6225 Fax: (905) 707-1775 Email: info@igeacare.com Web: http://www.igeacare.com/	-Home unit, available with video and medical peripherals.
McKesson Canada 4800 Lévy Street Saint-Laurent, Québec H4R 2P1 **Phone: (**514) 832-8333 or 1-800-361-3757 **Fax: (**514) 832-8049 Email: communication@mckesson.ca Web: http://www.mckessontelehealth.com/	**McKesson Telehealth Advisor**; -Health Hero Buddy Appliance is an in-home communication and monitoring appliance used in conjunction with an internet-enabled patient management system.
MED e-care Healthcare Solutions Inc. 710 Kingston Rd. Toronto, Ontario M4E 1R7 Phone: (416) 686-8592 or 1-800-387-8903 Fax: (416) 686-3861 Email: Carl@mede-care.com Web: http://www.mede-care.com	**MED e-care** -Healthcare software for the continuing care sector. Software that supports the MDS suite: Home Care, Mental Health, and Complex Care. As well as, software for the NRS, Careplanning, Incidental Charting, Scheduling, Resident Billing and ADT.
Mondial Lifeguard Technologies 9031 Milton Ave. Montreal West, Quebec H4X 2H1 Phone: (514) 448-6999 Fax: (514) 448-6688 E-mail: info@lifeguard-technologies.com Web: http://www.lifeguard-technologies.com/main.htm	**LifeguardSLU and LifeguardEMU** -Emergency alert devices that can be integrated with telemedical monitoring devices for cardiac and pulmonary indications
New IT 4 Place of Commerce, Suite 500 Montreal, QC H3E 1J4 Phone: (514) 762-2025 Fax: (514) 762-2007 Email: info@newithealthcare.com Web: http://www.newittech.com/	**Intelligence Distance Patient Monitoring (IDPM)** - Remote patient monitoring, disease management and a set of coordination tools encompassing cardiac, diabetes, pulmonary, pediatric, and other chronic diseases.
Philips Medical Systems, Canada 281 Hillmount Road Markham, ON L6C 2S3 Phone: (905) 201-4100 or 1-877-744-5633 Fax: (905) 201-4323 Email: Telemonitoring@philips.com Web: http://www.philips.ca/pdllp_medical/index.page	**Philips Remote Patient Monitoring** -Includes hardware, software, logistics, system management, software upgrades, training and ongoing support; TeleStation, weight scale, blood pressure and pulse unit, ECG heart rhythm strip recorder, pulse oximeter, glucose meter interface.
Second Opinion 3830 Del Amo Blvd, Suite 101, Torrance, California, USA 90503 Phone: **(**310) 802-6300 Fax: (310) 802-6311	**Second Opinion Home Health Units** -Lightweight notebook computers, digital cameras, and cell phones. Home monitoring unit includes real time ECG, heart rate, blood pressure, oxygen saturation, and body temperature,

Email: corp@2opinion.com Web: http://www.2opinion.com/medindex.htm	weight, and glucose monitoring capabilities.
Summit Technologies 5470 Harvester Road, Burlington, Ontario L7L 5N5 Phone: (905) 639-4440 or 1-800-268-7916 Fax: (905) 639-0099 Email: Margie@summittechnologies.ca Web: http://www.summittechnologies.ca/products/bodymedia.php	**BodyMedia® body monitoring system** The SenseWear® armband continuously records an array of physiological data which is then analyzed by InnerView® software applications. Collected data (up to 12 days) can be downloaded by physician, or by the patient, who then e-mails data to physician.
Telus Phone: 1-866-799-7777 Web: http://business.telus.com/en_CA/National/sector/Medium_And_Large_Business/Healthcare/natMlbHealthcare.html	**Interactive Doctor on Call (iDOC)** -Mobile lightweight cart housing high performance videoconferencing equipment and supports any line of set top codecs.
Thought Technology Ltd. 2180 Belgrave Avenue Montreal, Quebec H4A 2L8 Phone: (514) 489-8251 Fax: (514)-489 8255 E-mail: mail@thoughttechnology.com Web: http://www.thoughttechnology.com/	Telemonitoring Equipment -8 channel EEG, EMG,EKG, skin conductance, temperature, heart rate/ blood volume, pulse, respiration, goniometer, force etc.
Universal Medical Inc. 101 Ludlow Drive, Ewing, NJ USA 08638 Phone: (609) 671-1790 Fax: (609) 671-1765	**Heartrak 2 and Heartrak Smart** -ECG signals transmitted over telephone lines to hospital or physician.
VBrick Systems 12 Beaumont Road Wallingford, CT USA 06492 Phone: (203) 265-0044 or 1-866-249-7430 Fax: (203) 265-6750 Web: www.vbrick.com	Video products such as **EtherneTV**; network-aware appliances that allow organizations to build a video infrastructure on top of any existing IP network, capturing, recording, managing, distributing, and viewing your video assets.
Vitel Net Visual Telecommunications Network, Inc. 8201 Greensboro Drive, Suite 600 McLean, Virginia USA 22102 Phone: (703) 448-0999 Fax: (703) 749-9559 Web: http://www.vitelnet.com/	**ViTelCare™ monitoring system** -Touch screen in home monitors integrated with medical devices for management of a broad range of diagnostic groups including: heart failure, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, major depressive disorder and wound care assessment.
Viterion TeleHealthcare LLC 555 White Plains Road Tarrytown, NY, USA 10591 Phone: (914)333-6600 or 1-800-866-0133	**Viterion 100 TeleHealth Monitor** -Tool to supplement in-home visits with frequent monitoring and communications with the patient. Ability

Fax: (914) 333-6470 Email: info@viterion.com Web: http://www.viterion.com	to measure: blood pressure, blood oxygen, blood sugar, weight, temperature, and peak flow. Communications features include: customizable question/answer interaction, personalized advice messages for patient, flexible scheduling capabilities for measurements, questions, medications and reminders, important schedule and advice alerts and alarms.

Canadian Organizations involved in Telehealth and Industry Contacts

Atlantic Health Sciences Corporation
P O Box 5200
400 University Avenue
Saint John, NB E2L 4L4
Phone: 506-648-6042
Web: http://www.ahsc.health.nb.ca/Programs/Telehealth/telehealth.shtml
Canadian Health Infoway
Toronto Office:
150 King Street West, Suite 1300
Toronto, ON M5H 1J9
Phone: (416) 979-4606 or 1-888-733-6462
Fax: (416) 593-5911
E-mail: info@infoway-inforoute.ca
Web: http://www.infoway-inforoute.ca/en/WhatWeDo/TeleHealth.aspx

Capital Health
Capital Health Centre
Suite 200, North Tower
10030-107 Street
Edmonton, AB T5J 3E4
Phone: (780) 735-0668
Email: telehealth@capitalhealth.ca
Web: http://www.capitalhealth.ca/beamtelehealth

Clinidata Corporation (division of Sykes Assistance Services Corporation)
774 Main Street, 6th Floor
Moncton, NB E1C 9Y3
Phone: (416) 622-1652 or (506) 867-7919 or 1-877-671-8356
Email: info@clinidata.com
Web: http://www.clinidata.com

Infotelmed Communications Inc.
Verdun, Quebec
Email: admin@infotelmed.ca

Ontario Telemedicine Network
The Telehomecare Support Centre for the Telehomecare Phase One Program
1090 Don Mills Road, Suite 500
Toronto, ON M3C 3R6
E-mail: telehomecare@otn.ca

PraxES Emergency Specialists Inc.
1331 Brenton Street
Halifax, NS B3J 2K5
Phone: (902) 420-9725
Fax: (902) 420-9987
E-mail: admin@praxes.ca
Web: http://praxes.ca/

SickKids Telemedicine Program
The Hospital for Sick Children
555 University Avenue
Toronto ON M5G 1X8
Phone: (416) 813-8808
Fax: (416) 813-8351
E-mail: tele.health@sickkids.ca
Web: http://www.sickkids.ca/telemedicine/default.asp

Xwave
(a division of Bell Aliant)
1550 Enterprise Road, Suite 120
Mississauga, ON L4W 4P4
Phone: (905) 670-1225 or 1-877-449-9283
Fax: (905) 670-1344
Web: http://www.xwave.com/key_industries/industry.aspx?IdKey=2

APPENDIX 15: HOME TELEHEALTH PROGRAMS BY JURISDICTION

British Columbia

Vancouver Coastal Health Authority (VCHA)

Home Telehealth Program
A home telehealth program is under development as a pilot part of a Canada Health Infoway project for chronic disease management, "*CDM Care Connectivity Project* "

Target Population
Patients targeted have multiple chronic conditions, such as CHF, COPD, asthma, arrhythmias and pneumonia. There is also a proposal underway to target patients discharged home from ER with telemonitoring

Health Services Delivered
The proposed health services include home monitoring for BP, weight, PaO2, temperature, heart rate, respiratory rate, peak expiratory flow rate, and glucose level

Patient Criteria for Service Provision
Please see target population

Integration within Health Care Systems
This pilot project is part of VCHA's overall CDM strategy

(Beverly Mitchell, Vancouver Coastal Health Authority, Vancouver, BC: personal communication, 2008 Aug.)

Vancouver Island Health Authority (VIHA)

Home Telehealth Program
No, but a home telehealth program is planned for 2009.

Target Population
The program will focus on CHF patients with one or more co-morbidities, such as diabetes, COPD and hypertension.

Health Services Delivered
The home telehealth services will be delivered using store-and-forward technology to measure the patient's vital signs (i.e., weight, blood pressure, heart rate, and oxygen saturation levels). Patients with diabetes may also download their most recent glucose meter readings.

Patient Criteria for Service Provision
The criteria are currently under development. The final version will be added to a clinical policy and procedure manual set to be completed prior to the home telehealth program launch in 2009.

Integration within Health Care Systems
VIHA's home telehealth program will be integrated with the RHA's home and community care program as well as an integrated health network being funded through Health Innovation Funds.

A CHF nurse in the community will be responsible for the caseload of CHF patients regardless of where they live on Vancouver Island. Subsequently, the CHF nurse will liaise with general practitioners, cardiologists, and VIHA's heart function clinic to identify those patients suitable for home monitoring services.

Notes
British Columbia has submitted a provincial project charter for telehomecare through the Ministry of Health to Canada Health Infoway. VIHA is taking the lead on this project and Interior Health will also be a partner in the project. Program approval is pending.

(Jennifer Cormie, Vancouver Island Health Authority, Victoria, BC: personal communication, 2008 Feb.)

Fraser Health Authority

Home Telehealth Program
No

Notes
There is interest to establish a home telehealth program in the RHA; however there are two issues. The first issue is funding, and the second one relates to finding a technology solution that meets the RHA's privacy and security requirements. A request for proposal (RFP) was done in 2007, and three responses were received from industry. Only one manufacturer was able to meet the RHA's privacy and security requirements, but their product has not been approved by Health Canada yet. As a result, the development of a home telehealth program is on hold.

(*Maureen Wood, Fraser Regional Health Authority, Surrey, BC: personal communication, 2008 Sep.*)

Interior Health Authority

Home Telehealth Program
Yes

Target Population
Patients with CHF

Health Services Delivered
Asynchronous. The technology uses an ordinary phone line. Once the technology is placed in a patient's home, health care providers can monitor the patient from a distance, improving access to care for CHF patients in rural communities.

The home monitoring system, using text and voice prompts, guides the patient through the vital signs collection process. The patient's vital signs (i.e., weight, blood pressure, heart rate, and oxygen saturation levels), along with responses to individualized subjective questions, are encrypted and automatically transmitted to the Health Authority Server (Central Station), which

can be accessed by health care providers. The Central Station software triages patient data, suggests the extent to which immediate intervention is required, and whether or not a patient should be referred to their physician and/or have a home visit on that day. Health care providers access the Central Station to run vital sign collection report from Monday to Friday. Patient vital signs are collected seven days a week.

Patients with wounds are entered in the Pixalere application and images are taken at each home visit. The patient's file is updated regularly until the patient is well.

Patient Criteria for Service Provision
The admission criteria applied is based on the New York Heart Association Functional Classification, and patients need to be level 2, 3 or 4 before they are eligible for the program. The patient's family physician is involved in providing the referral.

Additional criteria includes: the patient needs to be able to manage the equipment (or a family member can help manage the equipment), they have to be able to stand on the scale to weigh themselves, and they have to have cognition. The home also needs to be safe for the equipment.

Integration within Health Care Systems
Yes. The Interior Health Regional Health Authority is considering expansion throughout the East Kootenay Health Service area (and later throughout the Health Authority). TeleHomeCare is integrated within the existing CHF program. There is interest in expanding the service model to include chronic disease management and COPD.

Notes
A business case has been prepared to expand TeleHomeCare throughout Interior Health for CHF, chronic disease management, and COPD.

(Loretta Zilm, Interior Health, Kelowna, BC: personal communication, 2008 Jan.)

Northern Health Authority

Home Telehealth Program
A pilot project on home wound care (TeleWoundCare) for the home and community care (HCC) is currently underway.

Target Population
Patients with wounds

Health Services Delivered
HCC nurses upload images of the patient's wounds to an application, Pixalere, for electronic charting of the patients.

Patient Criteria for Service Provision
Patients with wounds are entered in the Pixalere application and images are taken at each home visit. The patient's file is updated regularly until they are well.

Integration within Health Care Systems
A plan for a regional implementation of the TeleWoundCare program is currently in progress.

(Paula Young, Northern Health, Prince George, BC: personal communication, 2008 March)

Alberta

Alberta Health & Wellness

Home Telehealth Program
There are existing home telehealth programs delivered by Alberta regional health authorities and provincial boards. For example, the Northern Lights Health Authority has been using home monitoring technology for a range of services for over two years. RHAs are in the planning phase for a home telehealth program. Planning is intended to be complete and implementation is expected in summer 2008.

Target Population
As a province-wide initiative in home telehealth, the target populations were patients with diabetes, COPD, and cardiovascular diseases. Subsequently, each RHA will decide as early as fall 2008 what other target populations to include in order to meet their community needs.

Health Services Delivered
Health services delivered include monitoring the patients' vital signs and transferring physiological patient data to health care providers. Telehealth technology is used for home care clients consultations, such as wound management, palliative care or children's health.[346]

Patient Criteria for Service Provision
In the province-wide initiative, the patient criteria were selected based on facilitating data collection of clinical outcomes for conditions with high needs (e.g., diabetes, COPD, and cardiovascular diseases).

Planning is also being undertaken by each RHA to define the additional inclusion criteria to address their population needs. Some of the existing programs operated by Alberta regional health authorities are also using videophone technology.

Integration within Health Care Systems
Each RHA will define the integration strategies prior to implementing their home telehealth program.

Notes
Telehealth technology includes videoconferencing, peripherhal medical devices, web-based applications, videophones, and home telehealth units.[347]

(Tim Bulger, Alberta Health & Wellness, Edmonton, AB: personal communication, 2008 May)

Alberta Health Services- Chinook Health

Home Telehealth Program
No

Notes
Chinook Health is planning to develop a home telehealth program in the fall 2008.

(Joy Doram, Chinook Regional Hospital, Lethbridge, AB: personal communication, 2008 Aug.)

First Nations and Inuit Health-Alberta Region

Home Telehealth Program
No

Notes
There are no immediate plans to implement home telehealth in First Nations Communities.

(Gerda Stoof, Health Canada-First Nation and Inuit Health, Home and Community Care, Edmonton, AB: personal communication, 2008 Aug.)

Saskatchewan

Home Telehealth Program
SaskTel has launched a number of trials using a service call LifeStat™. This service will be launching commercially in the first quarter in 2008.

Target Population
Existing physiological measurements include blood pressure, blood sugars, weight, and Pulse Ox. Many other measurements will be coming soon for diseases such as hypertension, diabetes, COPD, asthma, and CHF. Also, the service targets "lifestyles" via monitoring of lifestyle, diet, and exercise conditions

Health Services Delivered
Currently, asynchronous data transfer with real time call back is delivered. In the future, real-time event monitoring (such as post acute discharge) will be allowed.

Patient Criteria for Service Provision
Exclusionary criteria for patients were created by specialists across the country.

Integration within Health Care Systems
LifeStat is currently integrated with select electronic medical records and has been designed to interoperate with the proposed "pan-Canadian" electronic health record solution. In addition, the team is working with the PIPS group and HealthLine in Saskatchewan.

(Colin McAllister, Salveo, Regina, SK: personal communication, 2008 Feb.)

Manitoba

Primary Health Care

Home Telehealth Program
As part of the Primary Health Care Transition Fund, Health Links-Info Santé was funded to develop a two-year project entitled *Chronic Disease Management of Congestive Heart Failure via Telehealth.*

The program provided nursing telephone support to patients with CHF in combination with family physicians and other health care providers. The program was carried out in rural and urban environments and had a rigorous research design for evaluation purposes.

The program goals were to:

- Demonstrate effective coordination and integration of health care providers to manage CHF via telehealth
- Demonstrate decreased health care usage (ER utilization, days of stay, re-admission rates)
- Demonstrate improved health outcomes/patient satisfaction
- Demonstrate patient acceptance of telehealth as means of access
- To carry-out an effective collaborative evaluation of the initiative

Target Population

The target population was patients in Winnipeg and Central RHA with CHF whom were nominated by the 83 participating family physicians in the project.

To qualify for the project patients needed to:

- Have congestive heart failure
- Be over 40 years of age
- Be functionally able to handle home telemonitoring and telephone triage (no significant visual, cognitive and physical impairments, or no rotary dial telephones)
- Speak English

Health Care Services Delivered

In-home monitoring equipment was provided to one-third of the participants, one-third of the participants received usual care (no intervention by Health Links-Info Santé) and one-third received care from the telehealth nurses (no in-home monitoring equipment)

The weekly monitoring schedule was:

- Monday and Friday surveys (weight and blood pressure)
- Wednesday survey (biological measurements, symptom assessment (breathing/cough, swelling, fatigue and chest pain or discomfort)
- Monthly survey (medication concerns and compliance, diet and fluid intake, and geriatric depression scale)

Patient Critieria for Service Provision

Family physicians nominated suitable candidates using the criteria outlined in the target population section.

Integration within Healthcare Systems

The preliminary evaluation results were such that ongoing funding has been provided to continue the initiative with the initial patients. Additional funding is being sought to expand the program to other patients with CHF and to patients with other chronic diseases (e.g. diabetes)

(Barb Wasilewski-for Roberta Vyse, Manitoba Health & Health Living, Winniepeg, MB: personal communication, 2008 Sept.)

Central Regional Health Authority

Home Telehealth Program

Yes

Target Population

Patients with renal failure, COPD, diabetes, CHF, pre-eclampsia, and/or hypertension are targeted

Health Care Services Delivered

No information available

Patient Criteria for Service Provision

Clients are referred to the Home Care for Telehealth program by a family physician and usually suffer from multiple health problems. The client must have the mental capacity to work with the monitoring equipment. By having clients on the monitors, they become more aware of their health problems and are given tools to manage their health. The client is "seen" daily per computer program. If changes are required (e.g. medication), they can be done by phone. Hence, clinic and ER visits are decreased.

Integration within Healthcare Systems

A program expansion in the health plan has been requested. The current equipment needs updating, and client care may be enhanced with more units available throughout the region.

(Jan Marie Graham, Central Regional Health Authority, Southport, MB: personal communication, 2008 Sept.)

Ontario

University of Ottawa Heart Institute (UOHI)

Home Telehealth Program

The UOHI hosts one of the largest telehome monitoring (THM) program in Canada, serving cardiac patients in the Champlain Local Health Integrated Networks (LHINs) in Ontario, Northern Ontario, Western Quebec, and throughout Canada. Over 400 patients have been followed since the start of the program in 2005.

Target Population

The target population includes HF patients with one readmission in one month or two readmissions in six months, de novo heart failure patients, patients recovering from cardiac surgery, patients requiring vital sign and/or arrhythmia monitoring, and cardiac patients with co-morbidities such as diabetes and hypertension.

In summary, any cardiac patient requiring frequent monitoring or trending of information to facilitate optimal clinical management is eligible.

Health Services Delivered

Cardiac clinical applications include: monitoring of fluid status, medication management, vital sign and arrhythmia monitoring, risk factor education, self-care education, and caregiver support.

Administrative and management applications include: coordination of care, care integration using other technologies, such as telemedicine and interactive voice response (IVR) follow-up and timely communication of patient data to primary care physicians and specialists. Telemedicine tends to be real time; THM may be either synchronous /asynchronous; IVR can be both, but tends to be more asynchronous.

Patient Criteria for Service Provision
See target population for inclusion criteria. Home care visits are not provided. Patients install the monitor in their own home and return by bus. Therefore, access to care is assured to remote rural and urban areas. Physician and non-physician referrals are accepted.

Integration within Health Care Systems
A Regional Cardiac Telehome Monitoring program for the Champlain LHINs is being implemented by having community partners identify patients and deploy monitors to these patients, who send their transmissions to the UOHI for follow-up. Three community centres are completed, and new communities will be added as funding becomes available.

Notes
The province is pilot-testing the use of home monitoring in family practice settings. In the Champlain LHIN, a model that uses home monitoring during the acute phase and then moves cardiac patients to IVR (automated calling) will be brought forth. There is interest from family health teams (primary care physicians) regarding the IVR being explored.

(Christine Struthers, University of Ottawa Institute, Ottawa, ON: personal communication, 2008 Jan.)

Ministry of Health and Long-Term Care

Home Telehealth Program
Telehomecare is available in a limited Phase One Program in Ontario. The Phase One Program is deploying Telehomecare to 600 patients from six Family Health Teams (FHTs), working in collaboration with Community Care Access Centres (CCACs). Implementation of the Program began recently and is expected to run until October 2008. The results of the Phase One Program will inform ministry decision-making about future expansion of Telehomecare.

Target Population
The Telehomecare Phase One Program is for chronic disease management patients with COPD and/or CHF. Diabetes may be included if there are insufficient patients identified for participation in the Phase One Program.

Health Services Delivered
Based on a collaborative model of care delivery that integrates the services of multiple providers focusing on the needs of the patient and the patient's capacity to self-care:

- FHTs will play a key role in collaboration with local CCACs

A specialized Telehomecare registered nurse (RH) based in the FHT will:

- Conduct the selection and eligibility assessment of patients
- Provide patient education
- Remotely monitor patients' clinical status•
- Follow established clinical guidelines and protocols for COPD and CHF in consultation with the primary care practitioner responsible for the overall care of the patient.

Patients use devices such as: Blood Pressure Monitor, Stethoscope, Heart Rate Monitor, Peak Flow Meter, Pulse Oximeter, Breath Sound Auscultation, and Weight Scale to monitor their condition and readings are transmitted daily to a server and reviewed by the Telehomecare RN. Live videoconferencing capability for conducting remote visits will also be provided to a subset of patients that would benefit from this functionality (e.g., isolated patients).

The Phase One Program is a time-limited intervention designed to enhance patient self-management skills and improve patient health status

Patient Criteria for Service Provision
The Phase One Program is currently using the following criteria for patient enrollment (for which we would expect to see significant benefit from Telehomecare):

Patients of the Family Health Team who:

1. are over 18 years of age
2. have an established diagnosis of COPD or CHF
3. require regular monitoring of their condition by a health practitioner
4. have had at least one emergency room visit or a hospital admission in the last year related to COPD or CHF
5. have their Primary Care Practitioner's approval for admission
6. are willing to participate in the Telehomecare Program
7. are capable of learning and understanding instructions or has a caregiver who is capable
8. live in a residential setting with a telephone line

FHTs have generally been using their electronic medical records to identify prospective patients meeting the eligibility criteria.

Integration within Health Care Systems
Integration strategies are currently under development as part of the Telehomecare Phase One Program

(Vytas Mickevicius, Ministry of Health and Long-Term Care, Toronto, ON: personal communication, 2008 Jan.)

North Simcoe Muskoka[21]

Home Telehealth Program
A home telehealth program, "Aging at Home", is in operation.

Target Population
Patients in North Simcoe Muskoka with chronic diseases.

Health Services Delivered
A system, Re-ACT, uses wireless technology to regularly monitor blood pressure, pulse, weight blood glucose and blood oxygen.

Patient Criteria for Service Provision
See target population.

Integration within Health Care Systems
The program will increase the patient's access to the health care system and to education programs and health information.

Notes
The home telehealth program is funded by the North Simcoe Muskoka-Local Health Integration Network and is a partnership among the North Simcoe Muskoka Community Care Access Centre, We Care Home Health Services and Healthanywhere, a division of Igeacare.

Quebec

Home Telehealth Program
Yes

Target Population
Patients with chronic diseases, specifically heart disease, diabetes, and high blood pressure.

Health Services Delivered
The home telehealth services delivered are primarily asynchronous.

Patient Criteria for Service Provision
Each RHA is responsible for developing patient criteria for service provision for its population.

Integration within Health Care Systems
Each RHA is responsible for developing integration strategies within the health region.

Notes
- Four integrated university health networks (réseaux universitaires intégrés de santé-RUIS) were created in 2003 to contribute to the improvement of the population health in the Quebec regions by ensuring specialized and highly specialized services as to close to home as possible. One avenue is through the development of telehealth services.[348,349]

(Christian-Marc Lanouette, Ministère de la Santé et des Services sociaux, Quebec City, QC: personal communication, 2008 Mar.)

New Brunswick[20]

Extra Mural Program in River Valley Health

Home Telehealth Program
A provincial telehomecare demonstrator project called *EMPcare@home* was established in the Extra Mural Program in River Valley Health in 2005.

Target Population
Patients with CHF and/or COPD and a higher level of previous hospital admission, or who require more than one professional home care visit per week are the focus; however, patients with other conditions, such as diabetes and hypertension are also eligible.

Health Services Delivered
Through a competitive request for proposal (RFP) in 2004-05, a home monitoring system that works on Plain old telephone service (POTS) technology was selected to monitor a patient's

weight, temperature, blood pressure, pulse, oxygen levels, and is equipped with customizable pre-recorded messages that ask the patient a series of subjective questions about their condition. Clinical graphical trend reports are automatically generated to support patient triage. This asynchronous telemonitoring solution does not require the use of a live video component. The home monitoring system is also designed to accept information from other diagnostic peripherals, such as a blood glucose monitor and electrocardiogram.

Patient Criteria for Service Provision
Patients selected for the project must have been eligible for the Extra Mural program services as per existing program criteria.

Integration within Health Care Systems
All EMP staff (nurses, dieticians, reparatory therapists in particular) use EMPcare@home as an integral component of their care delivery model (as opposed to a centralized telehomecare nurse model). All patients referred to EMP are assessed for their eligibility to receive this service.

Engagement of family physicians was accomplished through education sessions about the project, mail-outs, one on one interviews and distribution of program flyers.

Notes
- EMPcare@home was defined as a disease management approach to patient care with chronic disease, enabled by telehomecare.

- In November 2006, the Canadian Health Informatics Association presented the Implementation Team Co-Chairs for the EMPcare@home Initiative with the 2006 national award for Innovation in the Adoption of Health Informatics.

- In 2006, the Canadian Home Care Association named the EMPcare@home Initiative a National Leading Practice.

- In 2007, CCHSA accreditation team cited EMPcare@home as a national leading practice as part of the RVH Final Accreditation Report.

- Project Partners: River Valley Health; Department of Health; Atlantic Canada Opportunities Agency; Pfizer Canada; Medavie Blue Cross; Business New Brunswick.

- Contacts:
  - Chris DeJong, Administrative Director, EMP, RVH
  - Valerie Hagerman, Regional Director, Telehealth, RVH

Atlantic Health Sciences Corporation

Home Telehealth Program[350]
Post Cardiac Surgery Home Monitoring Program

Target Population
Patients whom have been discharged home anywhere in New Brunswick, Nova Scotia or Prince Edward Island following cardiac surgery at the New Brunswick Heart Center (NBHC) are the target population.

Health Services Delivered

This program facilitates 7 X 24 hour access for patients in their home to clinical specialists within the NBHC during their early discharge recovery phase. Currently using a usual phone line or POTS real-time video interactions for remote incision line/wound management and virtual patient assessments are conducted daily with these patients using this home monitoring technology.

Patients transmit their blood pressure, oxygen saturation, and real-time heart rate and rhythm to a nurse at the Heart Centre for review. During after hours, an on-call system is set up whereby the patients initiate a page via voicemail. The RN contacts the patients by videophone and, if determined necessary, the patients then send their vital signs as per the usual daily call. This information is transmitted to the central station at the NBHC and within minutes is electronically faxed to the nurse's home. The RN visually sees them as well as their vitals and determines what intervention, if any, is to occur. If an emergency room visit is required, the RN will call and send the infomation required to the patients' local emergency rooms. The goal is to address clinical presentations prior to them becoming urgent or emergent.

Patient Criteria for Service Provision

Patients residing in New Brunswick, Nova Scotia or Prince Edward Island, who underwent cardiac surgery in New Brunswick, are eligible.

Integration within Health Care Systems

The telehealth nurse liaises with an interprovincial emergency room staff, family physicians, community services, and cardiac surgeons, as appropriate, to facilitate the treatment and detection of clinical presentations, such as atrial fibrillation, failure and wound infections.

Notes

- The home monitoring program is the longest running home telehealth program in North America, celebrating its tenth year in 2008.
- It is also unique to North America and has been recognized as such with numerous awards for Innovation and Best Practice.

(Krisan Palmer, Atlantic Health Sciences Corporation, St. John, NB: personal communication, 2008 Aug.)

Telemonitoring Diabetes Program-Atlantic Health Sciences Corporation

Home Telehealth Program

In 2004, AHSC partnered to develop a regional diabetes e-learning portal to investigate their research hypothesis of whether patients would demonstrate as good as or better HBAIC results after receiving education and support on-line using the ROAM Anyware Group Portal, as those patients seen face to face in clinics.

Initial evaluation feedback from those piloted within a group of Gestational Diabetics, led to further development recommendations from motivational therapists and specialists in Chronic Disease Management. Results to date are showing that patients are receiving as good as results. The goal is to continue refinement in conjunction with the partnering Ontario hospital site and the local New Brunswick Anyware Group so as to deliver the best possible product to the patient.

Target Population
Any patient who receives a referral to Diabetic Education and Nursing Support can choose to come in to the clinic or utilize the web portal or both.

Health Services Delivered
A web portal that contains up-to-date education material relating to nutrition, exercise and footcare was developed and is currently maintained. Voice-over powerpoint presentations on this topic prepared by clinical specialists can be readily accessed. Moreover, nurses, dieticians and pharmacists may monitor and review individual patient information, such as activity levels, blood glucose, weight and blood pressure, entered from the patient's home (or community) computer. Once the patient has been set up with this capability, out–of-range values established for each individual are flagged, and clinicians are able to respond in a timely fashion by a telephone follow-up. Links to other websites deemed accurate and appropriate are also found on this portal.

Patient Criteria for Service Provision
Physician referrals, are accepted, and patients must have access to a computer.

Integration within Health Care Systems
This portal has become an integral point-of-care for patient care delivery within the existing and longstanding Diabetic Teaching Clinic.

(Krisan Palmer, Atlantic Health Sciences Corporation, St. John, NB: personal communication, 2008 Sep.)

Telediabetes Monitoring Initiative-River Valley Health

Home Telehealth Program
In June 2008, River Valley Health (Regional Health Authority 3) and its project partners launched a telediabetes monitoring initiative within two diabetic clinics and one First Nation Community within Health Region 3, Province of New Brunswick.

Target Population/ Patient Criteria for Service Provision
The first 60 patients have been selected according to the following mandatory selection criteria:

- Adult patients (18 years of age or older)
- Diagnosis of Type 1 or Type 2 diabetes
- Patient's HgAIc equal to or greater than 7
- Diabetes treatment may be medication and/or lifestyle usual careled.
- Registered as a patient receiving diabetes services from three sites involved.
- Patient provided written consent to receive telediabetes monitoring service
- Patient signs RVH equipment loan agreement for telemonitoring technology provided for their care
- Patient has access to POTS and/or wireless service
- Patient agrees to use Life Scan Glucose Monitor (provided to them) for duration of project
- Patients are able to use technology

Health Services Delivered
The Home Telemonitoring System selected for this initiative provides each patient with a six month telemonitoring service. Patients and health professionals have access to data to

effectively monitor critical patient physiological data, including blood pressure and blood glucose via Bluetooth technology combined with cellular and/or POTS. All devices and data archive facilities have met prevailing medical device licensing, privacy and ISO certification standards required in Canada.

Data are transmitted to a secure central storage server that can be accessed by health professionals for analysis and timely intervention. The data can also be accessed by the patient themselves for the purpose of self-management; thus, empowering them to take usual care and to take a more active role in the management of their own health. The system also enables approved family members to access data, allowing them to become part of the health care team and to benefit from reduced anxiety stemming from the stress of caring for loved ones living with chronic illness. In addition to having access to data on a secure web site, voice automated telephone technology automatically alerts patients and health professionals if a reading is outside normal range and requires immediate attention.

Integration within Health Care Systems

The project has been implemented in three of the 15 diabetic clinics in Health Region 3, NB located in Community Health Centres, hospitals and First Nation Community health centres. Project staff for this telemonitoring initiative is diabetic nurse educators and dieticians who are responsible for the diabetic clinic services in their facility. Family physicians serve on the Project Steering Committee and an Endocrinologist serves as a medical advisor. Faculty from the University of New Brunswick and their third-year university nursing students are providing additional support for the First Nation community site implementation. Should the third-party evaluation of this project be deemed successful, the intent is to expand this service to additional diabetic clinics in the region.

Notes

- Project partners are River Valley Health; First Nations and Inuit Health Branch, Health Canada; Oromocto First Nation; Aboriginal Diabetes Initiative, Union of New Brunswick Indians; Faculty of Nursing, University of New Brunswick; National Research Council, Fredericton, NB.

- Project Rationale is regular self-monitoring of blood glucose combined with appropriate action to readings thought to be paramount to usual careling HgA1c levels. Reducing HgAIC levels are a recognized indicator of success in diabetes disease management initiatives. Based on large prospective population-based studies, every 1% reduction in the HgA1c will decrease:
    - diabetic eye complications by 35%
    - diabetic kidney disease by 33%
    - nerve damage by 40%
    - heart disease by 16%
    - all diabetes related deaths by 25%
    - amputations by 50%

- Contacts:
    - Valerie Hagerman, Regional Director, Telehealth, RVH
    - Susan Lockhart, Diabetic Nurse Educator, Upper River Valley Hospital, RVH
    - Shirley Moffatt, Nurse Manager and Diabetic Nurse Educator, McAdam Health Centre, RVH
    - Shelley Frances, Aboriginal Diabetes Initiative, Union of New Brunswick Indians

(Valerie Hagerman, River Valley Health, Fredericton, NB: personal communication, 2008 Aug.)

Atlantic Health Sciences Corporation & Capital District Health Authority

Home Telehealth Program
A STARTEL research study in Atlantic Health Sciences Corporation (Region 2) is underway in conjunction with Capital District Health Authority in Nova Scotia for patients with CHF.

Target Population
Patients diagnosed with CHF are eligible in order to decrease their health utilization reaccess and improve their quality of life.

Health Services Delivered
Patients are provided with a home monitoring device that enables them to transmit their weight, blood pressure and heart rate to clinicians on a daily basis for one year. This information is reviewed daily and unscheduled calls to the patient are made as well as the established biweekly scheduled call depending on the information. All recruited patients are randomized to either the usual care group (i.e. usual care) or the intervention group (i.e. telehealth). Subsequently, the telehealth arm is further randomized into two groups: video or non-video.

Patient Criteria for Service Provision
Research inclusion and exclusion criteria were specifically designed for this initiative.

Integration within Health Care Systems
Upon completion of the research phase and if a positive evaluation is obtained, the intention is to transition from a project to an integral part of our program delivery, as per our post-cardiac home telehealth surgery program.

(Krisan Palmer, Atlantic Health Sciences Corporation, St. John, NB: personal communication, 2008 Aug.)

Nova Scotia

Home Telehealth Program
Currently, there are no home telehealth programs available in the province. A yearlong research/pilot project using home telehealth for the treatment of HF patients in Nova Scotia just began. This project is being done in collaboration with Atlantic Health Sciences Corporation, Region 2 in Saint John, New Brunswick.

Target Population
HF specialty care is provided to patients with a diagnosis of heart failure who may have difficulty with access to care. Patients will be enrolled for a period of one year.

Health Services Delivered
Patients take their weight, heart rate and blood pressure on a daily basis, and this information is automatically downloaded to the central provider stations at the Capital District Health Authority for monitoring and trending. Also, patients undergo a bi-weekly scheduled and structured interactive telehealth visit to assess the patient's heart failure clinical status. This live interactive telehealth visit has been further broken down into two groups. Half of the patients who receive home telehealth for heart failure will be receiving home units with video and audio interactive capability, while the other half of the units will be strictly used for monitoring and the interactive

visit with the patient will take place by using the telephone. At any time, should their condition necessitate, an unscheduled telehealth visit may occur.

Patient Criteria for Service Provision
This is a new research project under the direction of Dr. Jonathan Howlett at the Capital District Health Authority. Inclusion and exclusion criteria were developed to identify the patient population.

The initial target population includes patients who currently receive heart failure specialty care within the Halifax Infirmary Heart Function Clinic and who may also be new admissions or frequent flyers, diagnosed with heart failure on the cardiology units. In 2008, the Capital District Health Authority plans to reach out to other jurisdictions in Nova Scotia to enrol patients who may have difficulty with access to heart failure specialty care by working in conjunction with primary care physicians and cardiologists throughout the province.

Interested participants are brought in to the Halifax Infirmary for an initial face-to-face visit and a detailed heart failure care plan will be provided for them.

Integration within Health Care Systems
At the Capital District Health Authority, home telehealth will be integrated into the health care system as another method of delivering HF specialty care from the heart function clinic at the RHA.

(Michelle Currie, QEII Health Sciences Centre, Halifax, NS: personal communication, 2008 Jan.)

Prince Edward Island

Home Telehealth Program
A telehome care program does exist, but it is only offered within one home care region in the province.

Target Population
The target population has mostly been seniors (≥ 65 years old) although there is no restriction on the age limit. Some of the diagnoses include palliative care, hypertension, depression, COPD, asthma, post-myocardial infarction, post-cerebral artery, and diabetes.

Health Services Delivered
The service provided is a video monitoring unit that is manufactured by American Telecare. Clients and health care providers are able to see each other, and vital signs, such as blood pressure, pulse, oxygen saturation monitor, and heart and lung sounds are monitored.

Patient Criteria for Service Provision
The telehome care program's initial objective was to provide the patient and their family with the opportunity for the patient to die at home with dignity and with the least amount of medical and social stress possible.

Integration within Health Care Systems
At present there are no integration strategies. TeleHomeCare is a permanent program in the province's home care service delivery.

Notes
When the program began in 2000, it was a pilot project focusing only on palliative care. Since then, it has evolved and has been incorporated into the province's home care program to serve a broader range of clients.

(Virginia Ferris, Department of Health-Home Care, O'Leary, PE: personal communication, 2008 Feb.)

Newfoundland & Labrador

Home Telehealth Program
No

Notes
The province has developed a Telehealth Strategic Plan and Home telehealth is one of the 5 strategies identified. A needs assessment and scoping phase for home telehealth will be taking place in early 2008 for three to four months, that will engage all the RHAs and key stakeholders to determine the needs, criteria, direction, and anticipated costs of implementation for home telehealth in the province.

(Cindy Mosher, CADTH, St.John's, NL: personal communication, 2008 Jan.)

Northwest Territories

Home Telehealth Program
No

Notes
A nurse call center (telecare) is available to the public for all services applicable. In the current setting, the nurse phone support lines are not usually considered as home telehealth. There no plans to establish a home telehealth program in the territory in the next three years.

(Ashley Geraghty, Telehealth Services, Yellowknife, NWT: personal communication, 2008 Jan.)

Yukon

Home Telehealth Program
No

Notes
There is a territorial-wide telehealth network with stations located in the health centres and care facilities in all the small communities. This setting allows for communication on client issues and staff training, as well as discharge planning and follow-up from Whitehorse.

(Liris Smith, Continuing Care, YTG, Whitehorse, Yukon: personal communication, 2008 Jan.)

Nunavut

Home Telehealth Program
No

Notes

A telehealth network in Nunavut provides all communities in the territory with an array of health care services, social programs, and other services through teleconferencing both within and outside the territory.[351]

(Gogi Greeley, Department of Health and Social Services, Iqaluit, Nunavut: personal communication, 2008, Aug.)