The Added Value of Telehomecare for Heart Patients, Healthcare Professionals, and Healthcare Organizations

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List of Abbreviations

BPD	Blood Pressure Device
CAD	Coronary Artery Diseases
CHF	Chronic Heart Failures
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cardiovascular Diseases
DALY	Disability-Adjusted Life Year
ECG	Electrocardiography
GNP	Gross National Product
HRM	Heart Rate Monitor
ICD	Implantable Cardioverter Defibrillator
NYHA	New York Health Association
SCHFI	Self Care Heart Failure Index
SLR	Systematic Literature Review

Glossary

Added Value	When the primary or secondary outcomes are measured for both the intervention group and usual care group, and the results were in favor of intervention group.[1]
All-cause Hospitalization	Calculated as the proportion of participants readmitted to hospital at least once during the period of follow-up.[1]
All-cause Length of Stay	Number of days for hospitalizations.[1]
All-cause Mortality	Total number of deaths at the end of study follow-up in each arm of the study.[1]
All-cause Re-admission	A variable number of acute admissions for the same individual for an exacerbation of the same problem, a new problem, or a failure of the discharge process.[4]
Beta Blockers	Medication that decreases the heart rate and cardiac output, which lowers blood pressure and makes the heart beat more slowly and with less force.[2]
Cardiac Hospitalizatoin	Calculated as the proportion of participants readmitted to hospital at least once during the period of follow-up[1] due to cardiac events.
Cardiac Mortality	Total number of deaths at the end of study follow-up in each arm of the study[1] due to cardiac events.
ECG Device	A cardiac event recorder is a battery-powered portable device that you control to tape-record your heart's electrical activity when you have symptoms.[3]
Health Condition	The medical condition of the patient
Heart Failure Hospitalizatoin	Calculated as the proportion of participants readmitted to hospital at least once during the period of follow-up due to CHF.[1]
Heart Failure Length of Stay	Total number of days for hospitalizations[1] due to CHF.
Heart Failure Re-admission	A variable number of acute admissions for the same individual for an exacerbation[4] of heart failure.
Prisma Statement	The PRISMA Statement consists of a 27-item checklist and a four-phase flow diagram.[40]
Pulse Oximetry	Measures a persons oxygen saturation ($SO_{2)}$.[6]
Quality of Life	Health-related quality of life as assessed by validated questionnaires.[1]
Self Care Heart Failure Index	The SCHFI is a self-report scale, measuring multidimensional components of self-care: self-management, maintenance behavior, and self-confidence.[5]
Telehomecare	Uses modern technology to enable the communication and the transfer of information between the health care provider at the clinical site and the patient at his/her home.[7]

1. Abstract

Background. Currently little is known about the added value of telehomecare for CVD patients as experienced by patients, healthcare professionals and healthcare organizations. The aim of this study was to investigate the added value and the most commonly used devices with telehomecare by means of the following research question: "*what is the added value of telehomecare for heart patients, healthcare professionals and healthcare organizations?"*

Methods. The added value of telehomecare and the most commonly used devices were researched by means of a systematic literature review (SLR), meta-analysis, and semi-structured interviews. Inclusion criteria for the SLR and meta-analysis were: English language, peer reviewed, outpatient, non-invasive telehomecare used by patients with coronary artery diseases (CAD), cardiac arrhythmia, or chronic heart failure (CHF).

Semi-structured interviews were used to provide additional context on the added value which resulted from the SLR and meta-analysis. Study participants included medical staff, cardiologist, eHealth experts, and healthcare suppliers.

Results. 1462 studies were found in the initial literature search, respectively 44 and 25 met the inclusion criteria of the SLR and meta-analysis. All studies primarily focused on patients suffering from CAD or CHF. The most commonly used devices were weight scales, ECG devices, and blood pressure devices. In the articles included in the literature search, fifteen outcomes of added value were found for CAD and CHF. For CAD no outcomes were found which were in favor of the intervention group, whereas for CHF twelve outcomes were in favor of the intervention group, such as: all-cause/cardiac mortality, all-cause/CHF re-admission and LoS, all-cause/cardiac/CHF hospitalization, and Self Care Index of Heart Failure.

The participants provided additional information on the experiences of healthcare professionals, organizations and caregivers, which were lacking in the literature search.

Discussion. Resulting from the quantitative study is a reduction of hospitalization, re-admission and mortality. The qualitative research added experiences, such as an increased feeling of safety and the experienced troubles and lacking knowledge with the technology. Although added value of telehomecare is experienced by patients, healthcare professionals, organizations and caregivers, the latter three parties are underexposed in the literature. As such, further research and more attention should be given to telehomecare for CVD.

2. Research Plan

In this thesis, positive and negative outcomes influenced by telehomecare are investigated for patients with cardiovascular diseases (CVD), healthcare professionals, and healthcare organizations. This chapter presents the study's problem statement, research question, research methods, and research protocol.

2.1. Problem Statement

Due to the growth and aging of the population, the number of persons with a chronic disease will increase during the next 20 years.[8] This, together with more and better care per person, will result in increasing healthcare expenses,[9] accompanied by an increase in care demands and healthcare costs.[10] To keep healthcare affordable, it is suggested that patients be able to increase their self-management and self-care, which can be achieved by using *telehomecare.*[11]

The following definition of telehomecare is used in this study: "*Telehomecare* uses modern technology to enable the communication and the transfer of information between the health care provider at the clinical site and the patient at his/her home."[7] Telehomecare, which is part of *telemedicine*, is defined as a subset of telehealth that employs "communication networks for delivery of healthcare services and medical education from one geographical location to another, primarily to address challenges such as uneven distribution and shortage of infrastructural and human resources."[12] Telehomecare can help to inform patients about their disease, which enables them to be more involved in decisions about their health and be responsible for their own treatment.[11] This involvement and responsibility in turn gives patients the perception that they have more control over their lives.[11]

Telehomecare devices can be subdivided into two groups: implantable and non-implantable devices. Implantable devices, for example pacemakers and implantable cardioverter-defibrillators, automatically monitor patients and do not require any action by the patients themselves.[13] Non-implantable devices (e.g. ECG devices, weight scales, and blood pressure devices (BPD)), which are included in this research, are used by patients to measure their vital values (including electrical activity of the heart, weight, and blood pressure)[14] at home.

Telehomecare can be especially useful for patients with CVD, as they self-monitor their vital values with different telehomecare devices. This research therefore focuses on CVD, which is the second cause of death in the Netherlands.[15]

Knowledge regarding the added value of telehomecare for patients, healthcare professionals, and healthcare organizations is currently lacking – especially in the Netherlands. To make telehomecare a success, it is important to know how different parties experience it. Conducting research with a specific focus on the Netherlands is important, since healthcare systems differ all over the world and are strongly influenced by a nation's history, traditions, and political systems.[16]

The present study adds to the literature gap by providing insight into the known added value of telehomecare, as experienced by patients, healthcare professionals, and healthcare organizations, by means of a systematic literature review (SLR) and meta-analysis. Additional insight on the added value experienced specifically in the Netherlands is provided through semi-structured interviews. This combination of studies provides more insights into the added value of telehomecare and can serve as implementation guidance.

2.2.Research Questions

The following main research question is answered by the present study:

"What is the added value of telehomecare for heart patients, healthcare professionals, and healthcare organizations?"

The main research question is answered by means of the following sub-questions:

1. What is the added value of telehomecare for heart patients?
2. What is the added value of telehomecare for healthcare professionals?
3. What is the added value of telehomecare for healthcare organizations?

2.3. Research Methods

The research question is answered by means of different studies. Firstly, literature is reviewed via an SLR and meta-analysis to obtain background knowledge related to the subject of this thesis, the results of this literature review presented in chapter four.

The SLR investigates what has been researched previously regarding the added value and negative results of telehomecare for patients, healthcare professionals, and healthcare organizations. Where possible, a statistical analysis of a subset of the papers included in the SLR is provided to study the total added value of each factor. In addition to the overview of the added value of telehomecare, an overview of the devices most commonly used by patients with CVD is provided based on a literature review.

A qualitative study is also conducted to determine the added value of telehomecare for patients with CVD, healthcare professional, and healthcare organizations. To this end, semi-structured interviews are conducted with cardiologists, medical staff, healthcare provider, and eHealth experts. The aim is to recruit healthcare professionals by collaborating with ongoing telehomecare projects within the Netherlands.

2.4. Thesis Deliverables

A graphic representation of of the main deliverables of the research project is presented in Figure 1: a short proposal (1), a long proposal (2), and the thesis (3). These deliverables are subdivided into smaller sub-deliverables. The *short proposal (1)* is the first global plan, whereas the *long proposal (2)* is the initial literature study. Approval of both the short and long proposals is a prerequisite for starting the actual research, which leads to the final product: the *thesis* (3).

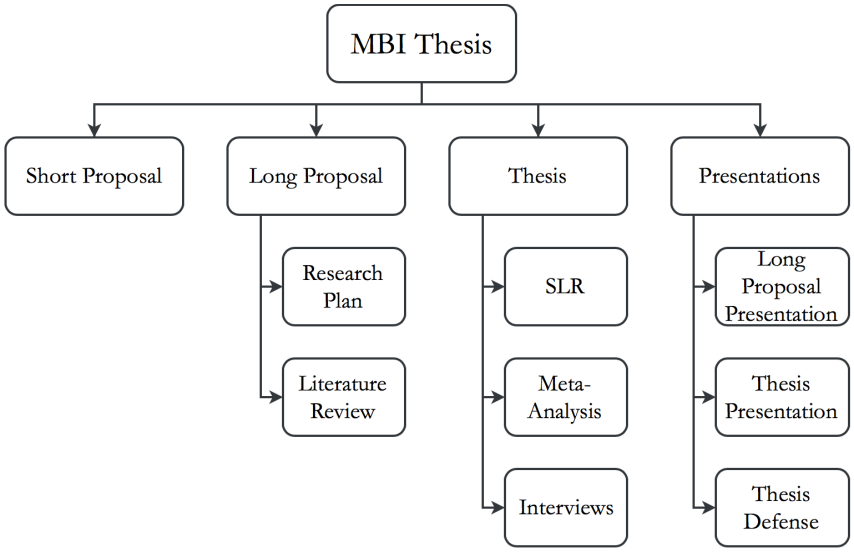

Figure 1. Product Breakdown Structure

3. Background

This chapter presents the findings of the literature research regarding the prevalence of chronic diseases, including CVD and the burden of disease noticed by patients, professionals, and society. It also outlines currently availably solutions, such as self-care and self-management. Lastly, an introduction to telehomecare and the added value of telehomecare is provided.

Due to the aging and growth of the Dutch population, the prevalence of most diseases in the past decade has increased. This increase is expected to continue;[17] in particular, it is foreseen that the trend will increase to 7 million in 2030 (accounting for 40% of the population), including the amount of people with comorbidity.[17] More than 5.2 million people had a chronic disease in the Netherlands in 2001, which accounts for 32% of the country's population.[17] Increases in the number of people with a chronic disease will result in consequences for the society.[15]

One of the main chronic diseases is CVD. Worldwide, CVD has the highest prevalence of all chronic diseases[18] and is the main cause of death.[19] An estimated 17.5 million people died from CVD in 2012, which represents 31% of all global deaths.[19] In the Netherlands, the prevalence of CVD was 862,000 in 2011.[15] Moreover, 39,300 people died as a result of CVD in the country in 2015, which represented 28% of total deaths and made it the second cause of death.[15] The prevalence of CVD is expected to increase to 1,426,000 in the Netherlands in 2040 due to the aging and growth of the Dutch population, which is an increase of 65% over 2011.[15]

Cardiovascular disease – which is also called heart and blood vessel disease or simply heart disease – includes numerous problems, many of which are related to a process called atherosclerosis. The condition atherosclerosis develops when plaque builds up in the walls of arteries, which causes them to narrow and in turn makes it harder for blood to flow through. If a clot is formed, the blood can stop flowing and a heart attack or stroke may occur.[20] Of the four most commonly occurring CVDs – such as coronary artery diseases (CAD), cardiac arrhythmia, stroke, and chronic heart failure (CHF) – strokes are often caused by other CVDs.[21] This research focuses on CAD, cardiac arrhythmia, and CHF, which are important to identify at an early stage to prevent worsening or other diseases or events (such as strokes).[22]

3.1. Burden of Disease

The burden of disease is high when a disease is common, lasts long, is relatively severe, causes many deaths, or a combination thereof.[17] Together with cancer and psychological disorders, CVD is responsible for the highest burden of disease.[17] Within CVDs, CAD, stroke, CHF, and cardiac arrhythmia have among the highest burden of disease;[17] they are also the CVDs with the highest prevalence.[23] Importantly, it is expected that CAD and diabetes will remain the diseases with the highest burden of disease in 2030.[24]

A first measure of burden of disease can be the number of years a patient lives with disabilities. That is, people who suffer from CVD have, together with psychological diseases, the highest number of years living with the disease.[25] For example, CADs are responsible for a high disability-adjusted life year (DALY), which is the sum of life years lost due to premature mortality and years lived with disability adjusted for severity.[26] Additionally, about half of the people with a chronic disease experience a high burden of disease with physical limitations that can affect their self-reliance and social participation.[25]

A final measure of burden of disease is social-economic costs. In particular, healthcare expenses are increasing due to the growth and aging of the population and the availability of more and better care per person.[9] In 2005, 13.5% of the Dutch gross national product was spent on healthcare, which amounted to €68.5 billion.[17]

The costs of common chronic diseases (CVD, cancer, diabetes, Chronic Obstructive Pulmonary Disease (COPD), depression, rheumatism) are together responsible for approximately 17% of total Dutch healthcare expenses.[27] A total of €8.3 billion was spent on cardiovascular diseases in 2011, which represented 9.2% of the total costs of Dutch healthcare (€89.4 billion).[28] Lastly, other costs for chronic diseases in general result from a loss of productivity through absenteeism and disability; however, decreased school performance and productivity in the workplace are also consequences.[27]

3.2. Self-Management and Self-Care

To keep healthcare affordable despite demographic changes, it is suggested that patients have more self-management and self-care. *Self-management* emphasizes the central role of patients in

managing their illness.[29] Programs that support self-management aim to help patients with medical management, maintaining life roles, and managing negative emotions. They also provide patients with the knowledge, skills, and confidence that they need to both deal with their illness and collaborate with healthcare professionals.[29] Self-care is defined as "a process of maintaining health through health promoting practices and managing illness."[30] There are three key concepts for self-care: self-care maintenance (e.g. taking medication as prescribed), self-care monitoring (e.g. regular weighing), and self-care management (e.g. changing diuretic dose in response to symptoms). The application of technology in the home setting can have positive effects on patients' self-management and self-care and may result in cost savings.[11]

3.3. Telehomecare

Telehomecare is a technology that aids in self-care and self-management. It is often used by people with a chronic disease, such as diabetes, COPD, or CVD.[31] Telehomecare "uses modern technology to enable the communication and the transfer of information between the health care provider at the clinical site and the patient at his/her home."[7] Telehomecare is defined as a subset of telemedicine, which uses "communication networks for delivery of healthcare services and medical education from one geographical location to another, primarily to address challenges such as uneven distribution and shortage of infrastructural and human resources."[12]

When engaging in telehomecare, patients use medical devices to assess their health status and transmit the data to clinicians for review and action.[32] As such, telehomecare systems allow patients' clinical parameters (such as their heart rate, blood pressure, blood oxygen saturation, blood glucose, electrocardiograph, and respiratory rate) to be captured with a sensor or other device.[33]

Telehomecare is not only used by patients. Healthcare professionals (such as nurses, and cardiologists) also employ telehomecare to provide healthcare from a distance in their daily practices.[33] Additionally, physicians' assistants and healthcare professionals outside the traditional healthcare infrastructure of clinics and physicians' consultation rooms work with telehomecare.[34] Healthcare professionals play a direct role in the implementation of

telehomecare, because patients are more likely to receive telehomecare services if these individuals recommend and support that they do so.[33]

3.4. Added Value of Telehomecare

Different outcomes are mentioned in the literature, which demonstrates that telehomecare changes the way in which healthcare is provided.[17] For example, telehomecare enables the early detection of diseases. As a result, patients can be treated earlier and their treatment can be better adapted to their particular situation – which may result in a healthier life.[17] Furthermore, research has proven the existence of a broad range of telehomecare benefits for patients (e.g. with heart failure), including substantial reductions in mortality rates and lowered hospitalization risks.[33] These studies suggest that telehomecare improves patients' quality of life, reduces healthcare costs, and is accepted by patients, which together will likely increase its usage.[33] However, telehomecare's added value for patients in terms of increased feelings of self-management or self-care remains a gap in the literature.

Knowledge on the added value of telehomecare for patients, healthcare professionals, and healthcare organizations is currently lacking. When the primary or secondary outcomes are measured for both the intervention group as the usual care group, and the results were in favor of the intervention group, it is defined as *added value.*[1]

An SLR, meta-analysis, and interviews are therefore performed to investigate the outcomes when comparing the usual care group with the intervention group, which provides an overview of the added value of telehomecare as experienced both worldwide and in the Netherlands.

4. Devices in Telehomecare used by Cardiovascular Diseases: A Literature Review

4.1. Introduction

Due to the aging and growth of the worlds population, the prevalence of most chronic diseases has been increased in the past decade – and this increase is expected to continue.[17] One of the main chronic diseases is CVD, which has the highest prevalence of all chronic diseases[18] and is the main cause of death.[7] Within CVD, the highest burden is caused by CAD, stroke, cardiac arrhythmia, and CHF.[17] The burden of disease is measured by years lived with disabilities, physical limitations, and social-economic costs.[9, 25]

To keep healthcare affordable despite the demographic changes, it is suggested in the literature that patients engage in more self-management and self-care.[29] The application of technology in the home setting can have positive effects on patients' self-care and self-management and may result in cost savings[11] and improved health outcomes.[1] An example of a technology that aids in self-care and self-management is telehomecare.[11] Telehomecare is increasingly used in healthcare, often by people with a chronic disease such as CVD.[36]

However, to the extent of our knowledge, no overview exists of the devices that are used in telehomecare and whether these devices differ by disease. Nonetheless, we believe that an overview of the current market demand could be useful for informing healthcare organizations and product suppliers about which devices are currently used in the market and the extent to which they differ by the type of CVD.

The objective of this SLR is to provide an overview of the devices and combinations of devices that are most commonly used in telehomecare. This will clarify how telehomecare is currently used in healthcare and the difference between the devices used for different CVDs.

4.2. Methods

Search Strategy

A systematic search was performed in March 2017 using the PubMed and Scopus databases to identify English-language, full-text articles that focus on the added value of devices used by healthcare professionals and patients with CAD, cardiac arrhythmia, or CHF in conjunction with telehomecare.

The following search query was built and used in the final search to be as broad as possible: ((telemonitor* OR telehealth OR telemedicine OR telehomecare* OR tele-mon*) AND (heart failure* OR coronary* OR arrhythmia*) NOT (implement* OR machine learning OR robot* OR meta-analys* OR review OR icd OR pacemaker* OR child* OR infant*)).

After the search strategy was applied and possible hits were identified, duplicate articles were removed. The titles and abstracts of the remaining articles were then reviewed, with irrelevant articles being excluded. Finally, the full-text articles were assessed to determine their appropriateness for inclusion. In Appendix A i.e., articles that were excluded based on the full-text assessment, and the reasons for their exclusion, are shown

Inclusion and Exclusion Criteria

Since the literature on the added value of telehomecare has begun to expand in the past 10 years, only articles that were published from January 2007 to March 2017 were included. Both observational and experimental as well as randomized clinical trials and quasi-experimental studies were included. English-language articles that investigate ambulant adult patients who are diagnosed with one of the CVDs with the highest prevalence in the Netherlands (i.e. CAD, cardiac arrhythmia, or CHF)[37] and are able to independently use telehomecare devices were examined. Additional inclusion criteria were that studies had to involve participants who use telehomecare devices to externally measure their vital value, and had to compare outcomes between an intervention group (telehomecare) and usual care group.

To ensure the quality of the included studies, we excluded grey literature, opinion papers, letters, and other unpublished material (in line with Coyne[38]). We also excluded SLRs and meta-analyses, although we checked their reference lists for any additional articles that would be

helpful to be consider to include in the SLR. Articles that investigate the usage of telehomecare outside the home setting were also excluded. Finally, articles that studied the added value for infants or patients with implementable telehomecare devices, such as pacemakers and implantable cardiac defibrillators, were excluded as well.

Data Extraction and Synthesis

The following data was extracted from the articles that were ultimately considered (as presented in Appendix B): (1) study country, (2) study duration, (3) sample size, (4) type of CVD, (5) description intervention group, (6) description usual care group, (7) healthcare professionals, (8) organization from which patients were recruited, (9) New York Health Association (NYHA)[1] classification, (10) training, (11) study methods, (12) study objective. The primary and secondary outcomes measured when comparing the outcomes between the intervention group and the usual care group are represented in Appendix C. Lastly, the used telehomecare devices are represented in Appendix D.

The next phase entailed describing the demographic data of the included studies. The number and types of devices were also categorized by disease to provide an overview of the devices used. The prevalence of common combinations of devices was also investigated.

4.3. Results

Search Outcome

The initial search resulted in 1462 studies being identified for this review, of which 1460 were found through the initial database search and 2 were identified through other sources. After duplicates were removed, the titles and abstracts of the remaining articles were screened. This screening stage led to 1195 studies being excluded, which resulted in 156 studies that were eligible for a full-text assessment. During the full-text assessment, 112 studies were eliminated for not meeting the inclusion criteria. As such, 44 studies remained in the final set for data extraction and inclusion in the SLR. Figure 2 provides a PRISMA Flow Diagram[40] that illustrates the process used for this literature search.

[1] NYHA places patients in one of four categories based on how much they are limited during physical activity.[31]

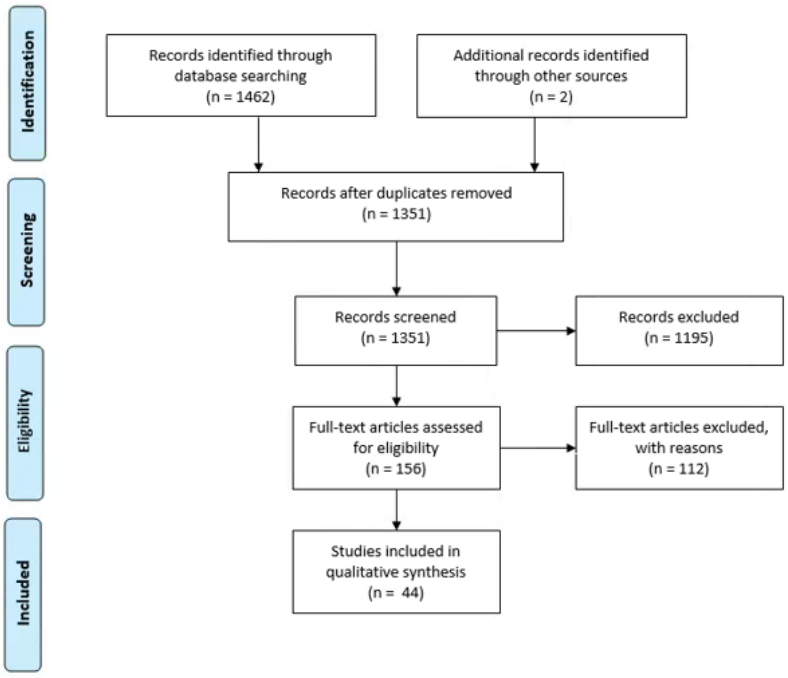

Figure 2. Prisma Flow Diagram: SLR on Telehomecare Devices

Study Characteristics

As shown in Table 1, a total of 44 studies remained in the final set and were examined for devices used by patients with CAD, cardiac arrhythmia, and CHF. No studies that focus on cardiac arrhythmia were found in this SLR. The percentages given for CAD and CHF are based on the total number of studies included in relation to each specific disease (CAD n=5, CHF n=39).

Most of these studies were conducted in Europe (48%) and North America (50%). Just over half of them were published between 2007 and 2012; the remaining studies were published between 2012 and 2017. Lastly, males were more present than females in 55% of the studies.

Table 1. Study Characteristics of the Included Studies: SLR on Telehomecare Devices

	Coronary Heart Disease	Cardiac Arrhythmia	Heart Failure	Total
Total number of studies	5	0	39	44
Place				
Europe	4 (80%)	0 (0%)	17 (44%)	21 (48%)
North-America	1 (20%)	0 (0%)	21 (54%)	22 (50%)
Asia	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Publication period?				
2007-2012	2 (40%)	0 (0%)	25 (64%)	27 (61%)
2013-2017	3 (60%)	0 (0%)	14 (36%)	17 (39%)
Sample size				
> 100 patients	3 (60%)	0 (0%)	23 (59%)	26 (59%)
> 100 healthcare professionals	1 (20%)	0 (0%)	0 (0%)	1 (2%)
Patients gender more present				
Male	5 (100%)	0 (0%)	19 (49%)	24 (55%)
Female	0 (0%)	0 (0%)	15 (39%)	15 (34%)

Telehomecare Devices

A total of eight different devices were used by patients with CAD or CHF in the included studies. The number and types of these devices can be found in Table 2; a more extensive overview is presented in Appendix D. Most of the studies (77%) included one to three devices. Weight scale and BPD are by far the most commonly used devices in the included studies, followed by heart rate monitors (HRM) and ECG devices.

The most commonly occurring combination of devices used is BPD with weight scales (as found in 57% of the studies). The combination of BPD and HRM occurs in 39% of the papers – which is noteworthy, since the HRM is only used in combination with the BPD and not as a

single device. The combination of weight scales and HRM is found in 36% of the articles, which indicates that HRM in all but one article occurs in combination with weight scales. The combination of a pulse oximeter and BPD also occurs often, namely in 23% of the articles. The pulse oximeter is used in 10 studies, always in combination with a BPD.

In relation to combinations of three devices, the trio of BPD, weight scale, and HRM is noticeable and occurs in 36% of the articles. In terms of combinations of four, the BPD, weight scales, HRM, and ECG devices are often found in combination, namely in 9% of the articles. A combination of five devices – namely BPDs, weight scale, HRM, ECG devices, and a device measuring urine output data – occurs in 5% of the articles.

Devices for Coronary Artery Diseases

In relation to combinations of three devices, the trio of BPD, weight scale, and HRM is noticeable and occurs in 36% of the articles. In terms of combinations of four, the BPD, weight scales, HRM, and ECG devices are often found in combination, namely in 9% of the articles. A combination of five devices – namely BPDs, weight scale, HRM, ECG devices, and a device measuring urine output data – occurs in 5% of the articles.

Devices for Chronic Heart Failure

In relation to CHF, the most commonly used combination of devices is BPD with weight scales (64%), followed by BPD and HRM (44%) and BPD and pulse oximeters (26%). As for combinations of three devices, BPD, weight scale, and HRM are often used together (41%). Two combination of four devices can also be found: BPD, weight scale, HRM, and ECG devices (10%) and BPD, weight scale, HRM, and pulse oximeter (8%).

Table 2. Information on the Devices Used with Telehomecare

	Coronary Artery Disease	Cardiac Arrhythmia	Chronic Heart Failure	Total
# of included devices				
1 – 3 devices	5 (100%)	0 (0%)	29 (74%)	34 (77%)
4 – 5 devices	0 (0%)	0 (0%)	10 (26%)	10 (23%)
Devices used in # of studies				
Blood Pressure Monitor	2 (40%)	0 (0%)	29 (74%)	31 (70%)
ECG Device	3 (60%)	0 (0%)	10 (26%)	13 (30%)
Heart Rate Monitor	0 (0%)	0 (0%)	17 (44%)	17 (39%)
Monitor Sensor	1 (20%)	0 (0%)	0 (0%)	1 (2%)
Pedometer	1 (20%)	0 (0%)	0 (0%)	1 (2%)
Pulse Oximeter	1 (20%)	0 (0%)	9 (23%)	10 (23%)
Urine Output Data Device	0 (0%)	0 (0%)	2 (5%)	2 (5%)
Weight Scale	0 (0%)	0 (0%)	34 (87%)	34 (77%)

4.4. Discussion

Main findings

In this systematic review, we synthesized recent evidence on the devices used for telehomecare for patients diagnosed with CAD, cardiac arrhythmia, and CHF. To our knowledge, this is the first SLR to systematically generate a list of devices that measure vital signs for telehomecare for patients with either CAD or CHF.

The SLR included 44 studies: 5 focused on CAD and 39 focused on CHF. No studies on cardiac arrhythmia were found. The literature reveals that the following eight devices are used in telehomecare for patients diagnosed with CAD or CHF: BPMs, ECG devices, HRMs, motion sensors, pedometers, pulse oximeters, urine output data devices, and weight scales. A study on non-invasive monitoring technologies for multiple chronic diseases also mentions BPM, HRM,

ECG devices, and pulse oximeters as devices commonly used to measure vital signs.[41] Of these devices, all but ECG devices are also found by Maric.[42]

The outcomes resulting from the SLR indicate that most studies using telehomecare CHF patients used one to three devices. In these studies, the weight scale and BPM are by far the most commonly used telehomecare devices both independently and in combination with each other. The second most occurring combination is BPM and HRM; here it is noteworthy that the HRM only occurs in combination with the BPD. Additionally, in terms of combinations of three devices used, the trio of BPD, weight scales, and HRM occurred most frequently. In Maric[42] it is mentioned that more than half of the included studies utilize a combination of methods for patient telehomecare.

Only a few studies included in this SLR investigating telehomecare for CAD and CHF mention the feasibility of telehomecare devices. Domingo[43] found that hardly any studies address the feasibility of telehomecare programs in daily practice. However, Maric[42] mentioned that the studies investigating telehomecare in relation to CHF do mentioned feasibility and they even think that the interventions will hold in the future.

Implications

It is expected that this SLR will have both practical and research implications. The former will mainly be noticed by healthcare organizations and product suppliers. If the devices used for telehomecare identified in this SLR are proven to be effective, patients with CAD or CHF could employ telehomecare to supplement the care they receive in a clinical setting. This information can be useful for healthcare organizations when they are deciding whether to invest in telehomecare. Issues relating to effectiveness, which are interesting for future research, are investigated in the following chapters.

The implications of the SLR will also be noticed by product suppliers. To add to suppliers' own user studies, this study provides an overview of the devices and combinations of devices used for patients with CAD or CHF that offers insights into the current market demand.

A review is also a useful to provide an overview on the number of emerging studies in the telehomecare field and therefore identified as an implication of the current research. However,

given the variety of used definitions of telehomecare, it can be that relevant studies are excluded from this SLR, even though other parties consider them important for this field. Future research is therefore recommended on different telehomecare devices, such as video-based telehomecare.

Limitations

To provide information on more recently used technology, this SLR considered only studies published after 2007. Although the literature search was accurate and thorough, it is still plausible that studies were missed. It is also possible that some studies were excluded from the SLR because they were classified using terms that differ from those used in this review.

Another limitation of this research is that studies were only included in the SLR if they investigate the added value of telehomecare, which may have resulted in some devices being omitted from our overview. Although this inclusion criterion provides the possibility to research the added value of the devices included in the overview, to provide a more accurate overview of the devices used in telehomecare it is recommended that future studies do not consider the added value factor.

It is also recommended that future research provide more information on why certain devices are more used than others. If possible, this research should investigate the feasibility outcomes of these devices as well.

In conclusion, eight different devices were identified through the SLR on telehomecare used by patients with CAD or CHF. Knowing what added value is experienced with telehomecare is useful because it clarifies how different parties currently experience telehomecare. This issue is therefore investigated by means of a second SLR, which is presented in the following chapter.

5. The Added Value of Telehomecare for Cardiovascular Diseases: A Literature Review

5.1. Introduction

Due to the growth and aging of the Dutch population, the prevalence of most chronic diseases has increased in the past decade; this increase is expected to continue.[17] One of the main chronic diseases is CVD,[17] which has the highest prevalence of all chronic diseases[18] and is the main cause of death.[14] As mentioned earlier, CAD, stroke, cardiac arrhythmia, and CHF have the highest burden of disease.[11] Among others, this burden of disease reflects socio-economic costs.[9, 25]

To keep healthcare affordable, it is suggested in the literature that patients should have more self-management and self-care, which can be achieved using technology such as telehomecare.[11, 29] Telehomecare is defined as follows: "*Telehomecare* uses modern technology to enable the communication and the transfer of information between the health care provider at the clinical site and the patient at his/her home."[7, 12]

However, it is debatable whether telehomecare is indeed enabling self-care and self-management that may have positive influences on the psychical and psychological conditions of patients with CAD, cardiac arrhythmia, or CHF. Many studies have researched the added value for CHF and yielded different outcomes;[1, 44, 45] this study adds to this body of work. Additionally, to our knowledge no SLR has been performed to investigate the added value of telehomecare for CAD, cardiac arrhythmia, CHF or healthcare professionals and providers.

The objective of this research is therefore to provide an overview of the positive and negatives outcomes of telehomecare, as perceived by heart patients, healthcare professionals, and healthcare organizations. The research aims to answer three sub-questions: *"What is the added value of telehomecare for heart patients?", "What is the added value of telehomecare for healthcare professionals?"* and *"What is the added value of telehomecare for healthcare organizations?"*

5.2. Methods

Search Strategy

A systematic search was performed in March 2017, using the PubMed and Scopus databases to identify English-language, full-text articles on the added value of telehomecare for patients, healthcare professionals, and healthcare organizations that focus on CAD, cardiac arrhythmia, or CHF. The following search words in titles, keywords, and abstracts were interlarded for the search query: (1) telemonitor*, (2) telehealth, (3) telemedicine, (4) telehomecare, (5) tele-mon*, (6) heart failure*, (7) coronary*, and (8) arrhythmia*. The reference lists of included articles were browsed for additional relevant articles; we also looked at key authors' publication lists.

The following search query was built and used in the final search: ((telemonitor* OR telehealth OR telemedicine OR telehomecare* OR tele-mon*) AND (heart failure* OR coronary* OR arrhythmia*) NOT (implement* OR machine learning OR robot* OR meta-analys* OR review OR ICD OR pacemaker* OR child* OR infant*)).

After the search strategy was applied and possible hits were identified, duplicate articles were removed. Articles' titles and abstracts were then reviewed, with irrelevant articles being excluded. Finally, the full-text articles were assessed to determine their appropriateness for inclusion. Appendix A presents a table that lists the articles that were excluded based on the full-text assessment and the reasons for their exclusion.

Inclusion and Exclusion Criteria

Since the literature on the added value of telehomecare has begun to expand in the past 10 years, only articles that were published from January 2007 to 2017 were considered for inclusion. Both observational and experimental as well as randomized clinical trials and quasi-experimental studies were included. English-language articles that investigate ambulant patients who have been diagnosed with either CAD, cardiac arrhythmia or CHF)[46] and are able to independently use telehomecare devices were included. Articles were also considered for inclusion if they have compare the primary and secondary outcomes between an intervention group (telehomecare) and a usual care group. Peer-reviewed articles, short surveys, and editorial literature were included.

To ensure the quality of the reviewed studies, grey literature, opinion papers, letters, and other unpublished material were not considered for inclusion (in line with Coyne[38]). Also excluded were SLRs and meta-analyses, although their reference lists were checked for any additional articles to include in the present review. Articles that investigate the usage of telehomecare outside the home setting were also excluded, as were articles that do not investigate the added value of telehomecare for multiple diseases or clearly state for which disease added value was found. Finally, animal studies and articles that study the added value for infants or patients with implementable telehomecare devices, such as pacemakers and implantable cardiac defibrillators, were excluded as well.

Data Extraction and Synthesis

The following data was extracted from the articles that were ultimately considered (as presented in Appendix B): (1) study country, (2) study duration, (3) sample size, (4) type of CVD, (5) description intervention group, (6) description usual care group, (7) healthcare professionals, (8) organization from which patients were recruited, (9) New York Health Association (NYHA)[2] classification, (10) training, (11) study methods, (12) study objective. The primary and secondary outcomes measured when comparing the outcomes between the intervention group and the usual care group are represented in Appendix C. Lastly, the used telehomecare devices are represented in Appendix D.

Quality Appraisal

The articles were investigated by the first author. When the author doubted an article's quality or questioned whether it should be included, the article was discussed with the first supervisor until an agreement was reached. Additionally, the PRISMA Statement[3], which consists of a 27-item checklist and a four-phase flow diagram, was used to check whether all items deemed essential were reported in the SLR (Appendix E).[40]

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[2] NYHA places patients in one of four categories based on how much they are limited during physical activity.[31]

[3] The PRISMA Statement consists of a 27-item checklist and a four-phase flow diagram.[40]

5.3. Results

Search Outcome

After the initial search, a total of 1462 studies were identified for the SLR: 1460 were found through the initial database searches and 2 were identified through other sources. After duplicates were removed, the titles and abstracts of the 1351 remaining articles were screened. This screening stage resulted in 1195 studies being excluded, which left 156 studies for full-text assessment for eligibility. In this full-text assessment, 112 studies were eliminated because they did not meet the inclusion criteria. As such, 44 studies remained in the final set for data extraction and were included in the SLR. Figure 3 provides a PRISMA Flow Diagram[40] that illustrates the process used for this literature search flow chart.

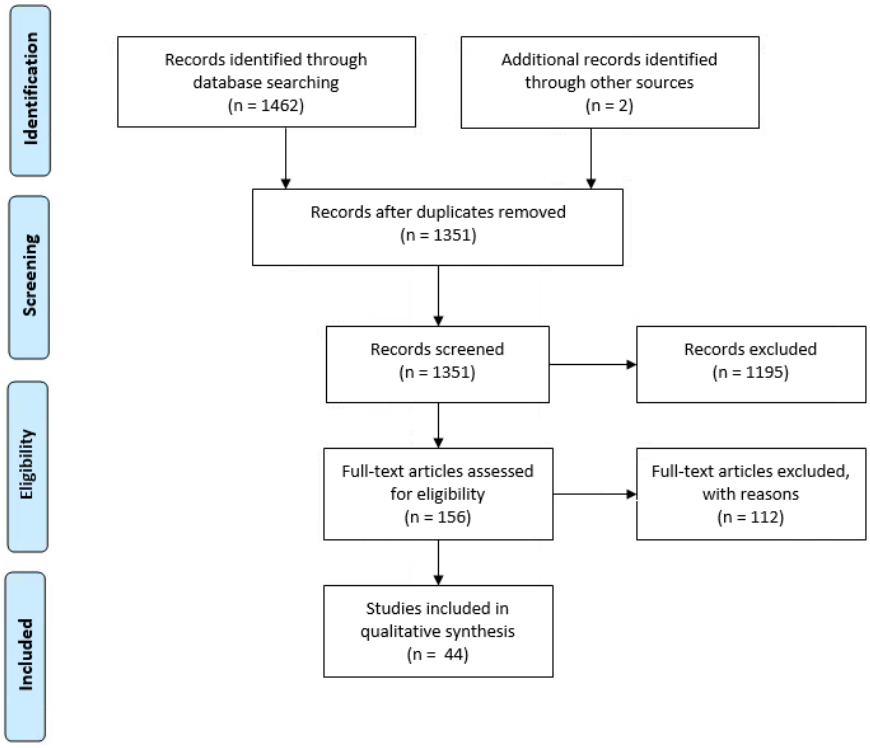

Figure 3. Prisma Flow Diagram: SLR on Added Value of Telehomecare

Study Characteristics

As shown in Table 3 (and an extended table in Appendix B), 44 studies examined the added value of telehomecare for CAD, cardiac arrhythmia, or CHF. Most of these studies were conducted in Europe (48%) or the United States (50%).

The SLR did not identify any studies that research the added value of cardiac arrhythmia. The percentages given for CAD and CHF are based on the total number of studies included in relation to each specific disease (CAD n=5, CHF n=39).

Table 3. Study Characteristics of the Studies Included in the SLR

	Coronary Heart Disease	**Cardiac Arrhythmia**	**Chronic Heart Failure**	**Total**
Total number of studies	5	0	39	44
Place				
Europe	4 (80%)	0 (0%)	17 (44%)	21 (48%)
North-America	1 (20%)	0 (0%)	21 (54%)	22 (50%)
Asia	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Publication period?				
2007-2012	2 (40%)	0 (0%)	25 (64%)	27 (61%)
2013-2017	3 (60%)	0 (0%)	14 (36%)	17 (39%)
Study duration				
> 6 months	2 (40%)	0 (0%)	28 (72%)	30 (68%)
> 1 year	2 (40%)	0 (0%)	11 (28%)	13 (30%)
Target group?				
Patients	5 (100%)	0 (0%)	38 (97%)	43 (98%)
Healthcare professionals	1 (20%)	0 (0%)	1 (3%)	2 (5%)
Sample size				
> 100 patients	3 (60%)	0 (0%)	23 (59%)	26 (59%)
> 100 healthcare professionals	1 (20%)	0 (0%)	0 (0%)	1 (2%)

Patients gender more present				
Male	5 (100%)	0 (0%)	19 (49%)	24 (55%)
Female	0 (0%)	0 (0%)	15 (39%)	15 (34%)
NYHA				
Class I	N/A	N/A	5 (13%)	5 (11%)
Class II	N/A	N/A	18 (46%)	18 (41%)
Class III	N/A	N/A	21 (54%)	21 (48%)
Class IV	N/A	N/A	16 (41%)	16 (36%)
Training				
Yes	2 (40%)	0 (0%)	19 (49%)	21 (47%)
Unknown	3 (60 %)	0 (0%)	27 (69%)	30 (68%)

Added value of Telehomecare

The literature presents 16 different outcomes that result from comparing intervention and usual care groups. Within these outcomes, a significant effect is found in favor of one of the two groups (extensive results are provided in Appendix D).

Table 4 presents the primary and secondary outcomes of the comparison between an intervention group and a usual care group. The significant positive results found indicate that the results are in favor of the intervention group and therefore have a positive effect for the patient, healthcare professional, or healthcare organization. In contrast, a significant negative result indicates that the results are in favor of the usual care group and therefore have a negative effect for the patient, healthcare professional, or healthcare organization.

The percentages given for CAD and CHF are based on the total number of studies included in relation to each specific disease (CAD n=5, CHF n=39).

In Chapter 6 a statistical analysis will be provided on the outcomes of the SLR. Additionally, the outcomes of both studies will be discussed in Section 6.4.

Table 4. Added Value of Telehomecare

	Coronary Heart Disease	Cardiac Arrhythmia	Heart Failure	Total
Costs				
Significant positive results	0 (0%)	0 (0%)	8 (21%)	8 (18%)
Significant negative results	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Emergency Department Visits				
Significant positive results	0 (0%)	0 (0%)	4 (10%)	4 (9%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Health Condition				
Significant positive results	1 (20%)	0 (0%)	6 (15%)	7 (16%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Health Perception				
Significant positive results	0 (0%)	0 (0%)	3 (8%)	3 (7%)
Significant negative results	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Healthcare Professional Perception				
Significant positive results	0 (0%)	0 (0%)	2 (5%)	2 (5%)
Significant negative results	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Healthcare Utilization				
Significant positive results	1 (20%)	0 (0%)	3 (8%)	4 (7%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Hospital Stay				
Significant positive results	0 (0%)	0 (0%)	6 (15%)	6 (14%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (0%)
Hospitalization				
Significant positive results	1 (20%)	0 (0%)	7 (18%)	8 (19%)
Significant negative results	0 (0%)	0 (0%)	2 (5%)	2 (2%)
Medical Intake				
Significant positive results	1 (20%)	0 (0%)	8 (21%)	9 (20%)

Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Mortality				
Significant positive results	1 (20%)	0 (0%)	8 (21%)	9 (20%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Perception of caregivers				
Significant positive results	1 (20%)	0 (0%)	2 (5%)	3 (7%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Physical Activity				
Significant positive results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Significant negative results	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Physiological Condition				
Significant positive results	1 (20%)	0 (0%)	0 (0%)	1 (2%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)
Re-admission				
Significant positive results	1 (20%)	0 (0%)	6 (15%)	7 (16%)
Significant negative results	1 (20%)	0 (0%)	2 (5%)	3 (7%)
Self-Care				
Significant positive results	0 (00%)	0 (0%)	5 (13%)	5 (11%)
Significant negative results	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Quality of Life				
Significant positive results	1 (20%)	0 (0%)	3 (8%)	4 (9%)
Significant negative results	0 (0%)	0 (0%)	1 (3%)	1 (2%)

6. The Added Value of Telehomecare for Cardiovascular Diseases: A Quantitative Analysis

6.1.Introduction

This chapter presents statistical analyses that were performed by means of a meta-analysis to study the added value of the findings from the SLR. The meta-analysis, which is a follow-up to the SLR, provides information on the primary and secondary outcomes of the studies that compare an intervention group with a usual care group.

The research aims to answer three sub-questions: *"What is the added value of telehomecare for heart patients?", "What is the added value of telehomecare for healthcare professionals?"* and *"What is the added value of telehomecare for healthcare organizations?"*

6.2. Methods

Search Strategy

This meta-analysis is a follow-up to the above-described SLR. As such, it used the same search strategy as the SLR (as described in the search strategy of the SLR).

Inclusion and Exclusion Criteria

Additional inclusion criteria to the previously described SLR were used for the meta-analysis. Articles were included when feasible given the available data; for example, the data had to be comparable to other studies, taking different research methods into account. A second inclusion criterion related to outcomes: an outcome was only included if a minimum of two published articles were available on it.

Data Extraction

In addition to the data extracted from the studies during the SLR, data was also extracted in the meta-analysis. Depending on the data available in each article, the following data was extracted: (1) the number of patients with an event, (2) the mean and standard deviation per subject, (3) the

cause of the event, (4) the sample size of the usual care group, and (5) the sample size of the intervention group.

Missing Data

Twenty authors were emailed concerning data missing from their studies, and five responded with additional information. The missing data of the remaining 15 studies was omitted from the meta-analysis.

Data and Analysis

Deciding which data to extract from the articles and include in the meta-analysis was done in consultation with the first supervisor (MA) for this thesis. The primary and secondary outcomes considered in the meta-analysis were identified according to the Mantel-Haenzel[47] methods. The mean difference[82] was included for the continuous outcomes, and the number of participants with events and total number of participants was included for the dichotomous outcomes.

All analyses were performed using Review Manager (RevMan) Version 5.3. Copenhagen: The Nordic Cochrane Center, The Cochrane Collaboration, 2014.

6.3. Results

Search Outcome

After an initial search, a total of 1462 studies were identified for this review: 1460 were found through the initial database searches and 2 were identified through other sources. After the removal of duplicates, the titles and abstracts of 1351 remaining articles were screened. In this screening stage, 1195 studies were excluded,[4] which resulted in 156 studies that were subjected to a full-text assessment for eligibility. This assessment led to 112 studies being eliminated because they did not meet the inclusion criteria, which left 44 studies for the qualitative synthesis. Of these 44 studies, 25 remained in the final set for data extraction and were included

[4] Five articles were excluded because they were not retrievable in any way.

in the meta-analysis. Figure 4 provides a PRISMA Flow Diagram[40] that illustrates the process used for this literature search.

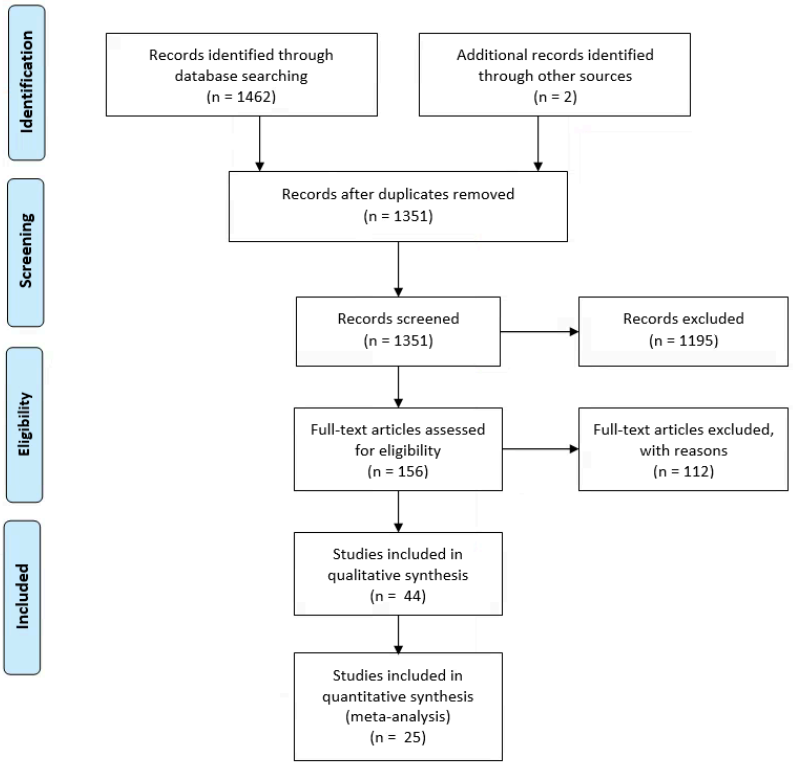

Figure 4. Prisma 2009 Flow Diagram: Meta-Analysis on Added Value of Telehomecare

Study Characteristics

In this meta-analysis, 25 studies that included a total of 8682 participants were identified (Appendix F). The study characteristics of the articles included are presented in Table 5. Of the considered studies, 2 studies looked at CAD and the remaining 23 focused on CHF. None of the studies focused on cardiac arrhythmia.

Table 5. Study Characteristics of the Included Studies in the Meta-Analysis

	Coronary Heart Disease	Cardiac Arrhythmia	Heart Failure	Total
Total number of studies	2	0	23	25
Place				
Europe	2 (100%)	0 (0%)	13 (57%)	15 (60%)
North-America	0 (0%)	0 (0%)	10 (43%)	10 (40%)
Publication period				
2007-2012	1 (50%)	0 (0%)	16 (70%)	17 (68%)
2013-2017	1 (50%)	0 (0%)	7 (30%)	8 (32%)
Study duration				
> 6 months	1 (50%)	0 (0%)	19 (83%)	20 (80%)
> 1 year	1 (50%)	0 (0%)	6 (26%)	7 (28%)
Target group				
Patients	2 (100%)	0 (0%)	23 (100%)	25 (100%)
Healthcare professionals	0 (20%)	0 (0%)	0 (0%)	0 (0%)
Sample size				
> 100 patients	1 (50%)	0 (0%)	17 (74%)	18 (72%)
> 100 healthcare professionals	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Patients gender more present				
Male	2 (100%)	0 (0%)	16 (70%)	18 (72%)
Female	0 (0%)	0 (0%)	6 (26%)	6 (24%)
NYHA				
Class I	N/A	N/A	4 (17%)	4 (16%)
Class II	N/A	N/A	14 (61%)	14 (56%)

Class III	N/A	N/A	16 (70%)	16 (64%)
Class IV	N/A	N/A	11 (48%)	11 (44%)
Training				
Yes	0 (0%)	0 (0%)	8 (35%)	8 (32%)
Unknown	2 (100%)	0 (0%)	15 (65%)	17 (68%)

Added Value of Telehomecare

In the meta-analysis, the primary and secondary outcomes of an intervention group and a usual care group were compared. A total of 15 primary and secondary outcomes were analyzed: 14 that focus on CHF and one that considers CAD.

CHF - All-Cause Hospitalization

Two studies[49, 50] measure the effects of telehomecare on the risk of all-cause hospitalization for patients with CHF (Figure 5). The results are in favor of the intervention group [RR-0.02, (95% confidence interval (CI) -0.31-0.27), P = 0.90 I^2 = 0%].

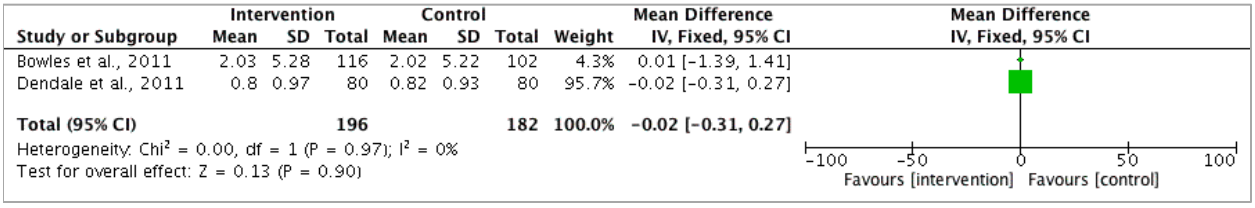

Figure 5. CHF - All-Cause Hospitalization

CHF - Cardiac Hospitalization

Three studies[51, 52, 53] measure the effect of telehomecare on the risk of cardiac hospitalization for patients with CHF (Figure 6). The results are in favor of the intervention group, which indicates that the usage of telehomecare reduces the proportion of patients hospitalized due to CVD [RR 0.70, (95% (CI) 0.54-0.89), P = 0.004 I^2 = 95%].

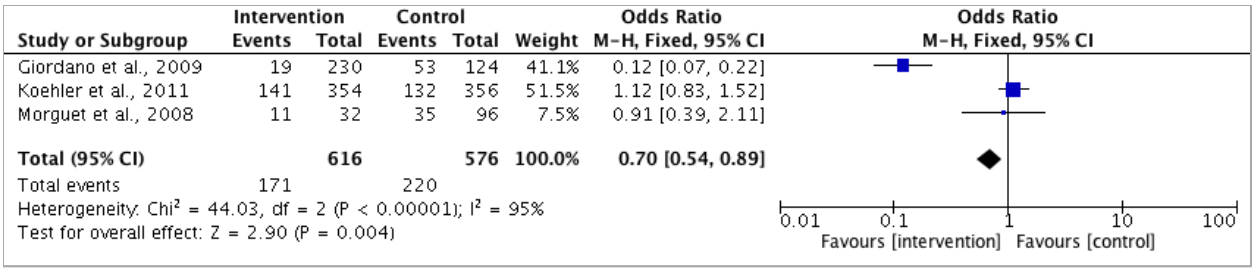

Figure 6. CHF - Cardiac Hospitalization

CHF - CHF Hospitalization

Four studies[52, 54, 55, 56] measure the effect of telehomecare on the risk of hospitalization for patients with CHF (Figure 7). The results are in favor of the intervention group; as such, the usage of telehomecare reduces the proportion of patients hospitalized due to CHF [RR 0.86, (95% (CI) 0.65-1.15), P = 0.32 I^2 = 62%].

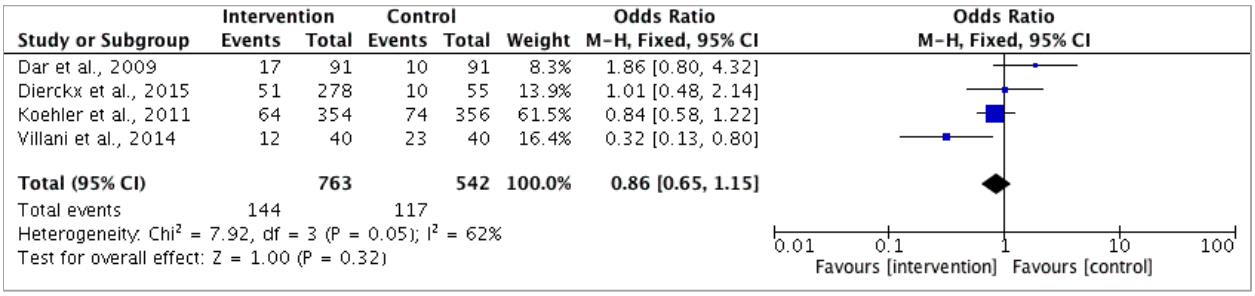

Figure 7. CHF - CHF Hospitalization

CHF - All-Cause Re-admission

Three studies[51, 57, 58] measure the effect of telehomecare on the risk of all-cause re-admission for patients with CHF (Figure 8). The results are in favor of the intervention group, which demonstrates that the usage of telehomecare reduces the proportion of all-cause re-admissions [RR 0.95, (95% (CI) 0.81-1.13), P = 0.58 I^2 = 76%].

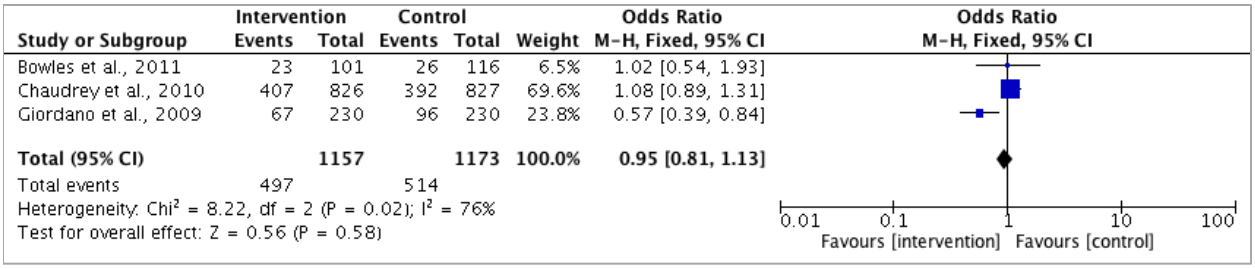

Figure 8. CHF - All-Cause Re-admission

CHF - CHF Re-admission

Four studies[23, 57, 58, 59] measured the effect of telehomecare on the risk of re-admission for patients with CHF (Figure 9). The results are in favor of the intervention group and therefore show that the usage of telehomecare reduces the risk of re-admission for CHF patients [RR 0.48, (95% (CI) 0.40-0.58), P = 0.03 I^2 = 66%].

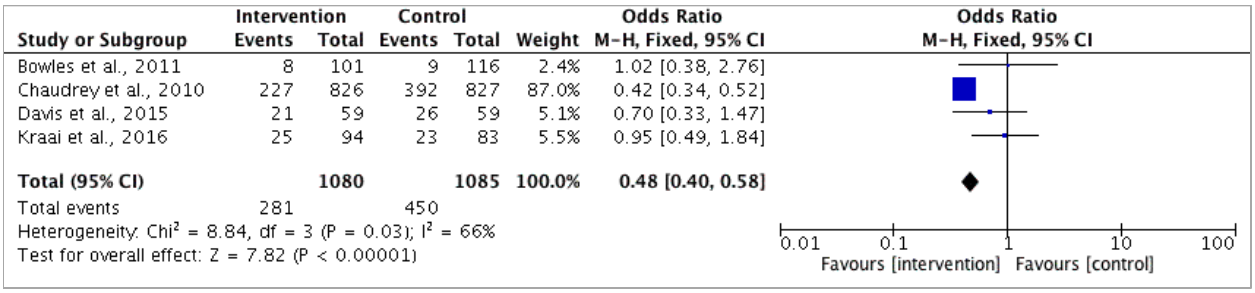

Figure 9. CHF - CHF Re-admission

CAD - All-Cause Re-admission

Two studies[60, 61] measure the effect of telehomecare on the risk of all-cause re-admission for patients with CAD (Figure 10). Figure 10 shows that the results are in favor of the usual care group, and therefore show that the us of telehomecare does not reduce the risk on all-cause re-admission [RR 1.06, (95% (CI) 0.87-1.31), P = 0.55 I^2 = 61%].

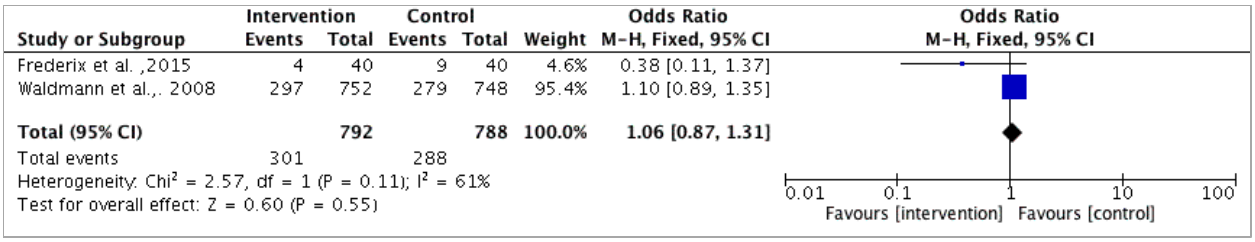

Figure 10. CAD - All-Cause Re-admission

CHF - All-Cause Mortality

Nine studies[50, 51, 52, 55, 58, 59, 62, 63, 64] measure the effect of telehomecare on the risk of all-cause mortality for patients with CHF (Figure 11). The results are in favor of the usual care group, which reveals that the risks of all-cause mortality are lower for the intervention group [RR 1.07, (95% (CI) 0.88-1.30), P = 0.48 I^2 = 82%].

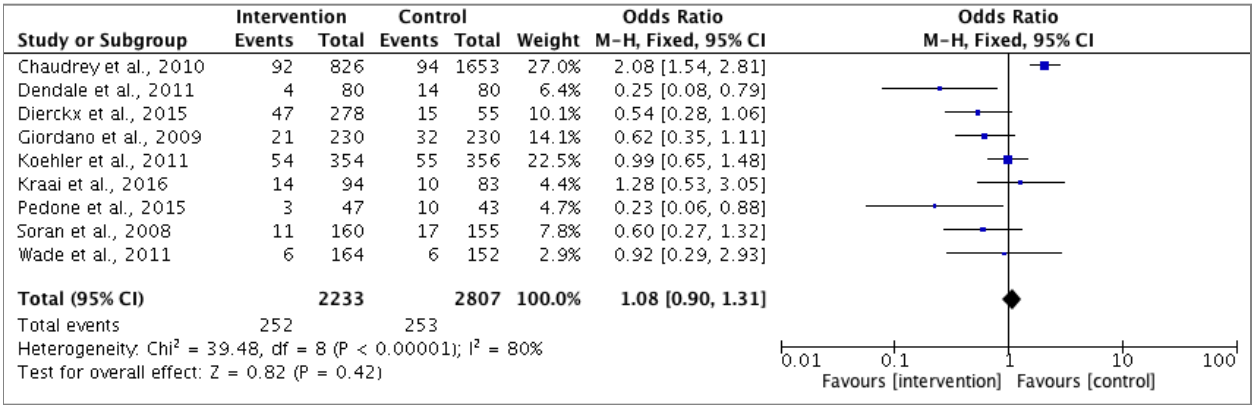

Figure 11. CHF - All-Cause Mortality

CHF - Cardiac Mortality

Four studies[51, 52, 55, 66] measure the effect of telehomecare on the risk of all-cause mortality for patients with CHF (Figure 12). The results are in favor of the intervention group, which indicates that telehomecare has a positive result on the risk of cardiac mortality [RR 0.72, (95% (CI) 0.53-0.99), P = 0.04 I^2 = 0%].

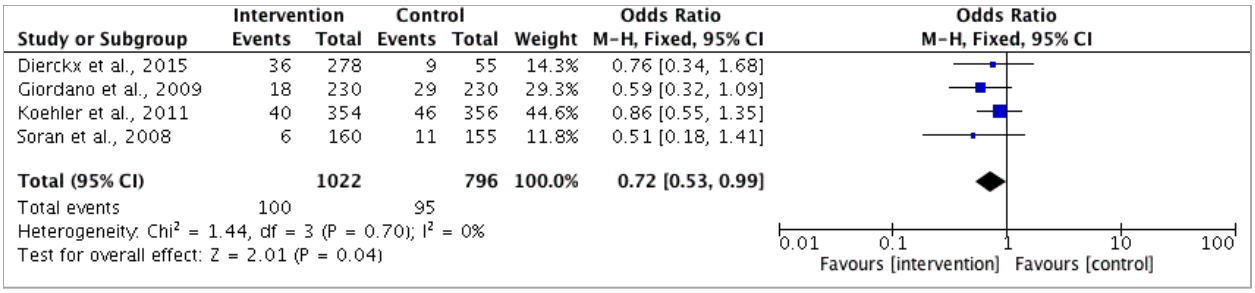

Figure 12. CHF - Cardiac Mortality

CHF - All-Cause Length of Stay

Two studies[55, 66] measure the effect of telehomecare on the length of stay (all-cause) for patients with CHF (Figure 13). The results are in favor of the intervention group, which shows that telehomecare reduces the length of stay in the hospital for all-cause reasons [RR -0.73, (95% (CI) -3.32-1.87), P = 0.58 I^2 = 0%].

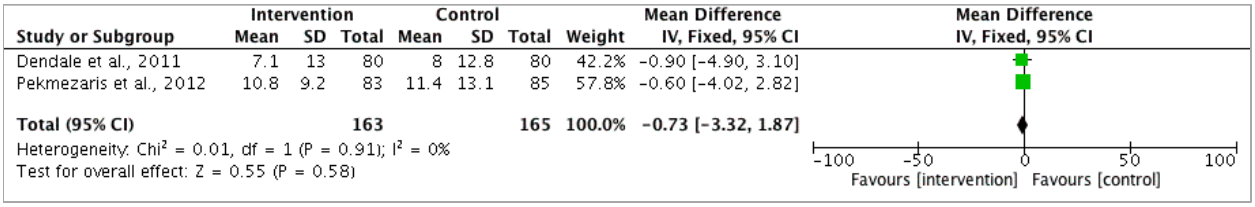

Figure 13. CHF - All-Cause Length of Stay

CHF - CHF Length of Stay

Two studies[50, 67] measure the effect of telehomecare on the length of stay (CHF) for patients with CHF (Figure 14). The results are in favor of the intervention group, which demonstrates that telehomecare reduces the length of stay in the hospital for all-cause reasons [RR -0.96, (95% (CI) -2.06-0.13), P = 0.08 I^2 = 0%].

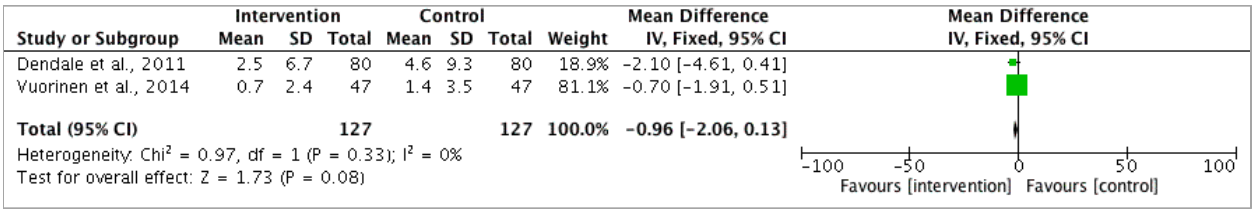

Figure 14. CHF - CHF Length of Stay

CHF - Self Care of Heart Failure Index (SCHFI): Self Management

Three studies[24, 49, 68] measure the effect of telehomecare on the level of self-management of patients with CHF (Figure 15). The results are in favor of the intervention group, which shows that telehomecare has a positive effect on the self-management of CHF patients [RR -43.74, (95% (CI) -43.74, - 36.60), P = 0.00001 I^2 = 98%].

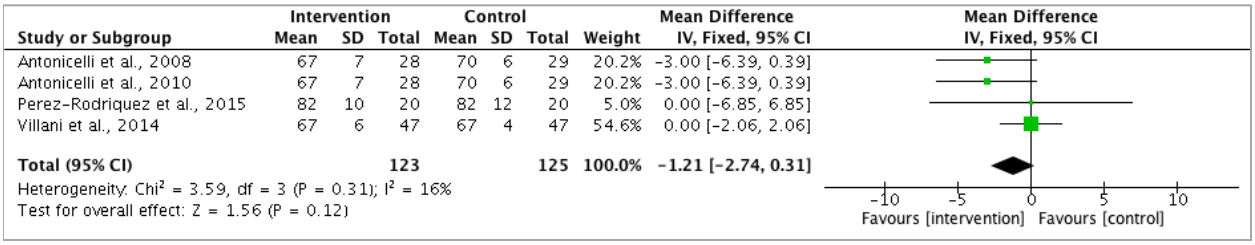

Figure 15. CHF - SCHFI: Self-Management

CHF - SCHFI: Self Maintenance

Three studies[24, 49, 68] measure the effect of telehomecare on the level of self-maintenance of patients with CHF (Figure 16). The results are in favor of the intervention group, which indicates that telehomecare has a positive effect on the self-maintenance of CHF patients [RR -22.65, (95% (CI) -26.65, -19.28), P = 0.00001 I^2 = 96%].

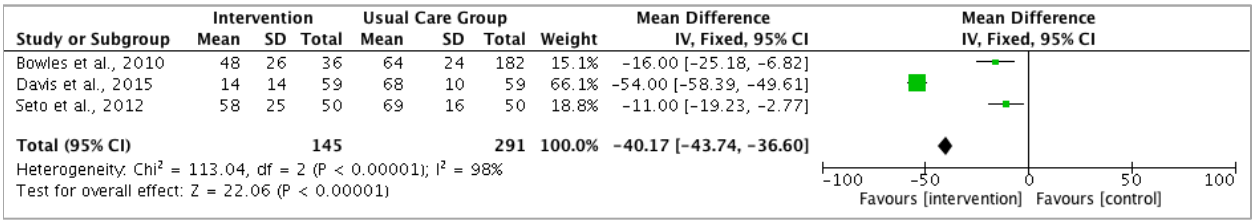

Figure 16. CHF - SCHFI: Self-Maintenance

CHF - SCHFI: Self Confidence

Three studies[24, 49, 68] measure the effect of telehomecare on the level of self-confidence of patients with CHF (Figure 17). The results are in favor of the intervention group, which reveals that telehomecare has a positive effect on the self-confidence of CHF patients [RR -8.38, (95% (CI) -13.20-3.56), P = 0.0007 I^2 = 61%].

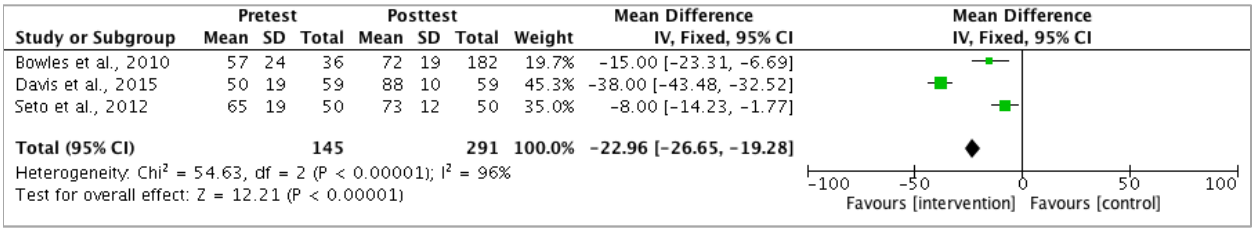

Figure 17. CHF - SCHFI: Self-Confidence

CHF - Heart Rate

Four studies[56, 69, 70, 71] measure the effect of telehomecare on the heart rate of patients with CHF (Figure 18). The results are in favor of the intervention group, which demonstrates that telehomecare has a positive effect on the heart rate of CHF patients [RR -1.21, (95% (CI) -2.74-0.31), P = 0.12 I^2 = 16%].

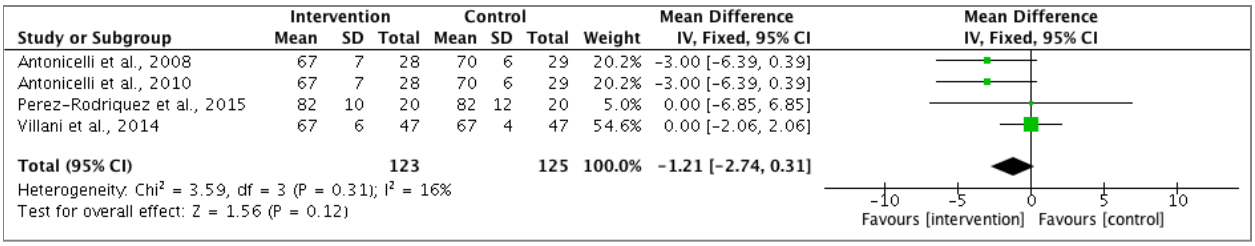

Figure 18. CHF - Heart Rate

CHF - Intake of Beta Blockers

Three studies[55, 68, 72] measure the medication intake of beta-blockers of patients with CHF (Figure 19). The results are in favor of the usual care group and therefore show that telehomecare has a negative effect on the medication intake of CHF patients [RR 1.86, (95% (CI) 1.39-2.51), P = 0.0001 I^2 = 0%].

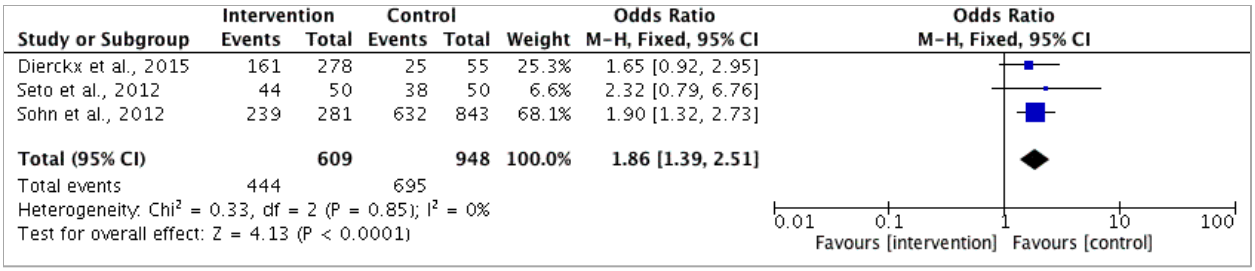

Figure 19. CHF - Intake of Beta Blockers

6.4. Discussion of the Literature Studies

This thesis has examined the added value of telehomecare for patients, healthcare professionals, and healthcare organizations by means of an SLR and meta-analysis. These studies aims to answer the following three sub-questions: *"What is the added value of telehomecare for heart patients?", "What is the added value of telehomecare for healthcare professionals?"* and *"What is the added value of telehomecare for healthcare organizations?"*

Main findings

In the SLR and meta-analysis, the recent evidence on the added value of telehomecare for patients diagnosed with cardiac arrhythmia, CAD, or CHF is synthesized. The SLR considered 44 studies, of which 5 focus on CAD and 39 focus on CHF; no articles were found on cardiac arrhythmia. In the meta-analysis 25 studies were considered, of which 2 focus on CAD and 23 focus on CHF. The findings can be subdivided into four groups: patients, healthcare professionals, healthcare organizations, and caregivers.

Patients

Almost all of the studies included in the SLR and meta-analysis focus on outcomes as experienced by patients. Multiple outcomes were found in the SLR; if the data allowed, these outcomes were compared in the meta-analysis.

For CAD one outcome has been research in the meta-analysis: all-cause re-admission, which was in favor of the usual care group. One paper has been found researching the

readmission for CAD, of which the results showed that significantly fewer patients in the intervention arms had multiple readmissions.[73]

For CHF, 14 outcomes were included in the meta-analysis, of which the following 12 were in favor of the intervention group: all-cause/cardiac/CHF hospitalization, all-cause/CHF re-admission, all-cause/cardiac mortality, all-cause/CHF length of stay (LoS), self-management, self-maintenance, self-confidence, and heart rate. The results for LoS (all-cause and CHF) and hospitalization (all-cause and CHF) are confirmed by Inglis[1] Inglis[74], and Kitsiou[75]. The remaining two outcomes, namely all-cause mortality and the intake of beta-blockers, were in favor of the usual care group. The effects on beta blockers confirms the results of Cleland[76]. The negative results found in relation to all-cause mortality contradict the results of Inglis[1] Inglis[74], and Kitsiou[75]. No studies that confirm the results of this meta-analysis were identified.

Healthcare professionals

The literature review identified two studies that examine healthcare professionals' perceptions of telehomecare in the context of CHF. Both studies found significant positive results, although it was not specified what positive experiences were discovered. The positive perceptions of healthcare professionals are acknowledged in Radhakrishnan[77] and Lindberg;[78] however in Radhakrishnan[77] negative experiences are mentioned as well.

Healthcare organizations

The advantages of telehomecare for healthcare organizations relate to cost-effectiveness, which is investigated in eight studies on CHF. All of these studies found significant positive results on the cost effectiveness of telehomecare, which confirms the findings of Inglis[74] and Seto.[79]

Caregivers

A few studies have investigated the added value of telehomecare for caregivers. For CAD one study has investigated the added value, which was mentioned to be significantly positive. As for CHF, three studies examine the outcomes; two find significantly positive results and one study finds significantly negative results. However, none of the studies, either focust on CAD or CHF

has specified what was experienced by the caregivers. To the best of our knowledge, only a few studies that explore caregivers' perceptions of telehomecare are available; of which Lindberg[80] mentioned the importance of focussing on the users of telehomecare: the patients and family members, in order to make telehomecare a success. A different study[79] emphasizes a negative perception of caregivers, but does specify the negative perception.

Implications

Implications for Practice

Compared to usual care, the implementation of telehomecare reduces mortality, hospitalization, re-admission, and LoS and improves self-care behavior and heart rate. As such, telehomecare should be considered to improve the quality of care for patients with CAD or CHF.

The experiences of telehomecare users can be a key factor in the successful delivery of telehomecare. It is therefore recommended that future research examine these experiences and use them as a guidance of implementation.

Implications for Research

This study has demonstrated that much is known about the added value of telehomecare as experienced by patients. However, healthcare professionals, healthcare organizations, and caregivers are shown to be underexposed in the literature. It is therefore recommended that research focus on these parties, because including them will provide more information on their experiences – which will likely have positive results on the acceptance of telehomecare

Lastly, many studies provide a quantitative view on the added value of telehomecare; however, studies on the context of telehomecare are lacking. It is therefore recommended this context be addressed through qualitative studies.

Limitations

In the literature study, no literature was included for cardiac arrhythmia. This likely stems from the study's limitation of using the inclusion criterion that patients should already be diagnosed

with a disease. As telehomecare is often used to diagnose people with cardiac arrhythmia, relevant studies may have been excluded. It would be interesting for future research to investigate the use of telehomecare to diagnose people with cardiac arrhythmia.

In the literature study, limitations can also be found in relation to the dataset. Due to a lack of data, only a few studies could be included for each outcome in the meta-analysis. Many of these outcomes had varying follow-up times, which may have influenced the results of the meta-analysis.

7. The Added Value of Telehomecare for Cardiovascular Diseases From the Professionals Perspective: A Qualitative Study

7.1. Introduction

Telehomecare initiatives occur commonly in conjunction with CVD, since it is one of the main chronic diseases worldwide, has the highest prevalence of all chronic diseases,[18] and is the most common cause of death.[19] As mentioned earlier, CVD is not only a chronic disease with a high prevalence; it may also have a heavy burden of disease on patients. Shifting this burden of disease to patients' homes can facilitate the self-care process, giving them enhanced autonomy and control in relation to their healthcare.[1] This shifting can be achieved through telehomecare.[1] Telehomecare programs can be flexible and individually tailored and have the potential to provide access to specialist care for a larger number of patients than usual care.[1, 82, 83]

However, these advantages seem to be underexposed in the Netherlands. Not much is currently known about the telehomecare experiences of patients, healthcare professionals, or healthcare organizations; information on the experienced added value by healthcare professionals and organizations is missing in particular. When the added value for healthcare professionals is mentioned in the literature, it is only noted that healthcare professionals are either positive or negative about telehomecare; substantive details regarding what they do or do about telehomecare are not provided.

However, since expanding telehomecare in CHF is a focal point in the National Implementation Agenda eHealth,[84] and is increasingly used in the Netherlands by people with CHF.[85] It would be interesting to know how people working with eHealth, such as healthcare professionals, medical staff, eHealth experts and product suppliers, experience telehomecare and view its challenges and downsides.

These experiences are presented in this chapter, based on an analysis of interviews who not only provide information on their experiences but also highlight the importance of involving local experts in research on telehomecare, and provide more information on the context of telehomecare. This could be interesting for healthcare organizations that are involved in developing new telehomecare programs in the Netherlands.

7.2. Methods

Research Objectives

The objectives of this study were to examine the positive and negative outcomes of telehomecare for patients, healthcare professionals and healthcare organizations in the Netherlands. To achieve this objective the experiences of healthcare professionals, medical staff, eHealth experts and healthcare providers were examined. Additionally, the aim of this study was to develop an understanding of the meaning and experiences of the people working with telehomecare.[86] This study supplements the findings of the SLR and meta-analysis by conducting semi-structured interviews to explore the views of the participants on using telehomecare for CVD in the Netherlands.

Sample

Our participants included healthcare professionals, medical staff, eHealth experts and healthcare providers. These four professions were selected for interviews because they provide different perspectives on telehomecare. Healthcare professionals provide information as users of telehomecare and have in-depth knowledge of patients' experiences. Healthcare providers are responsible for deciding how telehomecare should be used in the medical setting and are therefore knowledgeable of medical organizations' processes. They are also often informed of recent studies that examine the effects of telehomecare. The last group of participants, eHealth experts, provides a broader view on telehomecare. These participants are researchers who investigate the usage of telehomecare. As such they are well informed on the subject.

Due to the scope of this study, no patients were interviewed to obtain information on the added value of telehomecare or direct insights into their experiences, therefore, the interviews included a focused partially on patients' experiences. Even though no patients were interviewed, it is believed that the participants can help to provide a broad context related to patient experiences due to their frequent contact with patients.

eHealth experts provided the contact details of healthcare professionals, medical staff, other eHealth experts and healthcare providers who were contacted via e-mail and received a gentle reminder one week later.

Participants were interviewed between March and June 2017. The interviews took place either at the interviewee's workplace or by telephone. A list of the participants, including their job titles, years of experience in their current function, years of experience with telehomecare, age, and organization they work for, is included in Appendix G.

Interview Protocol

An interview protocol, shown in Appendix H, was used to construct the semi-structured interviews. A qualitative study is a vital addition on the current telehomecare evidence base which is largely focused on outcomes rather than on the spectrum of people and processes that can shape telehomecare.[87] The goal of this study was to explore the experiences of people working with telehomecare; patients, healthcare professionals, and healthcare organizations.

The first topic addressed in the protocol was the experiences of patients with telehomecare. The first two questions were about both positive and negative experiences of patients. These questions derived from Oudshoorn[34] who mentioned that although the changing role of patients is addressed, no detailed empirical research on the use practices and experiences is found in the literature. Secondly, one question is asked in the protocol about the experiences between different cardiovascular diseases. Thirdly, since it is shown that certain demographic characteristics influence the care process and hospital-based case outcomes for patient's,[88] the participants were also asked to what extent the patient's demographic characteristics and type of CVD influences patients' experiences. Lastly, questions are asked in the protocol about the reasons of denying to use telehomecare.[77]

The second topic address in the interview protocol is about the experiences of healthcare professionals. As mentioned by De Vries,[89] the expectations and consequences of telehomecare for the work of healthcare providers is rarely studies, and thus unclear. However, these aspects of telehomecare are vital for the consideration and acceptance of telehomecare.[90] Therefore, two questions of the protocol are devoted to the positive and negative experiences of healthcare professionals.

The last topic addressed in the interview protocol are the experiences of healthcare organizations. Important when looking into the experiences of telehomecare for healthcare

organizations is the cost-effectiveness, of which is appears that the specific context in which the project takes place (different patients, environments, technologies and healthcare systems) are important.[91] Therefore, the experiences of healthcare organizations are addressed in the interview protocol.

The interview protocol was revised and refined iteratively together with the second supervisor (BvL) to ensure that no information was missed during the interviews. The interview protocol was also refined during the interviews. Since not all participants were available for the same amount of time, some questions had to be omitted.

The added value of telehomecare and examining the experiences of the participants were explored using an inductive approach, which helped to answer the research questions. An inductive approach implies that the investigators learn from the experiences gained throughout the research,[90] which are projected into patterns and support statements made in the research.

Data Collection

The interviews occurred face-to-face in the workplace or via telephone. They lasted from 30 to 60 minutes and were conducted by one master student. All interviews were audio recorded and subsequently transcribed verbatim (using ExpressScribe Version 6.04) to avoid interpretations before the data was analyzed on the basis of coding.

The interviews were conducted and transcribed in Dutch. The data analysis was performed in Dutch and translated in English. The final transcripts and quotes were sent to the participants for corrections and additions. The participants approved the results and were assured that their interviews would remain confidential and that the researcher would report findings anonymously.

Data Analysis

For the data analysis, the grounded theory has been used, which is defined as follows: “a general methodology of analysis linked with data collection that uses a systematically applied set of methods to generate an inductive theory about a substantive area.”[93] This theory emphasizes the

systematic approach of data collection, handling, and analysis, with joint collection, coding and data analysis as the underlying.[93]

Once collected, the data was coded using NVivo for Mac, version 11.4.1. Although this computer software cannot be seen as a way to make an analysis more rigorous, it is helpful for working with large amounts of text.[94] As described by the grounded theory, the coding process started with open coding, which involved data analysis.[95] In open coding, the researcher assigns names and labels to particular parts of an interview transcript.[95] As the open coding process moved forward, an iterative reflection of what had already been coded led to new codes and changes to the names of codes. As a result, interviews that had already been coded were checked and recoded as necessary.[95]

After open coding, the next step in the coding process was axial coding.[95] In this type of coding, relationships between open codes are identified for the purpose of developing core codes.[91] These core codes emerge as aggregates of the most closely interrelated open codes that the researcher believes to be associated with each other.[96] In the current study, this process resulted in two types of codes: open codes, which are the topics mentioned in the interviews, and core codes, which summarize the main topics of the relevant open codes. The open codes were aggregated into the core codes. Both the open and core codes are shown in Appendix I.

In the last coding step identified in the grounded theory, namely selective coding, the central concepts of the interviews are demonstrated.[96] In this steps, the relationships between the concepts are demonstrated by showing the central concepts resulting from the interviews.

To establish the validity of the qualitative project, a senior reviewer (BP) identified the coding procedure. This was done by recoding one interview and review all code descriptions and studies which text fragments were linked to each code, which also helped to establish the validity of the coding process.[96] This validity check was the basis for a discussion on the meaning of the codes, the best labels (i.e. names of the codes), and the code hierarchy (i.e. main codes and their sub-codes). As a result of this discussion, several codes were renamed or added and open codes were moved to other core codes. These changes improved the overall quality of the codes.

7.3. Results

In this qualitative study, participants were asked to describe the added value of telehomecare. Supporting quotations from the interviews are provided below.

To provide an overview of the sample, information on the participants is presented in Table 6. A total of 15 participants (87% male) were interviewed: 5 cardiologists, 5 eHealth experts, 2 medical staff, and 3 healthcare providers. The respondents have a mean age of 43 ± 12 and work at 12 different organizations in the Netherlands. The mean years of experience of the participants in this position is 8 years ± 5. The mean years of the participants' experience with telehomecare is 4 years ± 2.8.

Table 6. Interviewee Characteristics[5]

Characteristics	*Respondents (n=15)*
Sex	
Female	2
Male	13
Mean age	42
Youngest	26
Oldest	65
Role	
Cardiologist	5
eHealth expert	5
Medical staff	2
Healthcare provider	3

Effects of Demographic Characteristics

The participants mentioned different demographic outcomes that they think it influences patients' experiences with telehomecare. The following characteristics, shown in Table 7, were cited: "age," "digital skills," "education," "independence," "location," and "sex."

[5] The mean age of two participants is missing, which has an influence on the mean age

Experiences related to these demographic characteristics seem to differ significantly among the participants, such as the experiences with age and sex. For example, 20% of the participants believe that older people have more difficulties working with technology, in contrast to 13% who believe that the age does not have an effect. The following quotations indicate these differences:

> *"You work with older patients, who are not always as experienced in technology […]" (healthcare provider #1)*

However, other participants perceive the influence of age on patients' technical skills differently:

> *"First I thought that older people would not get it, but this is just not true […]" (medical staff #1)*

Another demographic aspect that arose more frequently than others during the interviews was the patient's sex (20% of the participants). When they were discussing this issue, participants tried to identify a relationship between the patient's sex and technical skills. Their experiences are varied; some (7%) say that one sex often has more experience in using technology, whereas others said they had not experienced any difference at all (13%):

> *"[…] and they [women] may be even better with the technology than men. They already have smartwatches. They are women on age, but already very involved with it [with the devices used in telehomecare]." (medical staff #2)*

Table 7. The Influence of Demographic Characteristics on Telehomecare

	Effect mentioned by # participants	Role (number of participants)	No effect mentioned by # participants	Role (number of participants)
Age	3	Cardiologist #2 eHealth expert #1	2	Medical staff #1 Healthcare provider #1
Digital skills	1	Cardiologist #1		
Education	2	Cardiologist #2		
Patient independence	1	Cardiologist #1		
Location	1	Cardiologist #1		
Sex	1	Cardiologist #1	2	Cardiologist #1 Medical staff #1

The Effects of Telehomecare as Experienced by Patients

During their interviews, the participants were asked about patients' experiences with telehomecare. They mentioned many positive outcomes that patients enjoy as a result of telehomecare; those commonly cited include "time efficiency," (40%) "feeling of safety," (47%) "more and better patient information," (33%) "patient involvement," (67%) and "patient compliance" (33%).

Nonetheless, healthcare professionals, healthcare providers and eHealth experts did not only mention positive outcomes in relation to patient experiences; they also identified multiple negative outcomes during their interviews. Outcomes that were mentioned frequently and therefore seem to be important for the participants included "burden of telehomecare," (47%) "quality and timelines of contact," (33%) "technical issues," (40%) and "technical skills" (33%). Both positive and negative experiences are described in Table 8.

Above it is noted that patients are more involved with the disease, which was experienced by the participants as positive. However, healthcare professionals and providers also interpret this negatively. They noted that patients sometimes start to feel sicker and therefore experience an increased burden:

"[…] especially with that project, we noticed that people started to feel sicker, because their illness was moved to the home environment, literately. This also has to do with a feeling of responsibility – people had the feeling they had to do more with their disease." (eHealth expert #1)

Lastly, 13% of the participants mentioned some patients experiences that are neither positive nor negative. The participants mentioned that the physical activity of the patients, when they rehabilitate from home with telehomecare, was neither better nor worse than the experiences they had with patients in the usual care. For example:

"It is not negative per se, but a year later this group did not have more physical activity than the usual care group, which we did expect in advance." (cardiologist #5)

Table 8. The Effects of Telehomecare Experienced by Patients

	Positive effect mentioned by # participants	Role (number of participants)	Negative effect mentioned by # participants	Role (number of participants)	No effect mentioned by # participants	Role (number of participants)
Time efficiency	6	eHealth expert #3 Healthcare provider #2 Medical staff #1	1	Cardiologist #1		
Feeling of safety	7	Cardiologis #2 Healthcare provider #3 Medical staff #2				
Health condition	3	Cardiologist #1 Healthcare provider #1 Medical staff #1				
Health confidence	1	Medical staff #1				
Healthcare utilization	3					
ED visits	1	Cardiologist #1				
Length of stay	1	Healthcare provider #1				
Re-admission	1	Healthcare provider #1				
More and better patient information	5	Cardiologist #2 Healthcare provider #1 Medical staff #2				
Patient involvement	10	Cardiologist #4 eHealth expert #1 Healthcare provider #3 Medical staff #2	3	Healthcare provider #1 Medical staff #1 eHealth expert #1		
Patient compliance	5	Cardiologist #2 eHealth expert #1 Medical staff #2				
Patient satisfaction	2	Cardiologist #1 Healthcare provider #1				
Quality of Life	2	Healthcare provider #2				
Tailored care	3	Cardiologist #2 eHealth expert #1				

Uptitration	4	Cardiologist #2 Medical staff #1 Healthcare provider #1				
Burden of telehomecare			3	Healthcare provider #1 Medical staff #1 Cardiologist #1		
Burden of measuring			2	Cardiologist #1 Medical staff #1		
Felt sicker			2	Healthcare provider #1 eHealth expert #1		
Lack of motivation			3	eHealth expert #1 Healthcare provider #1 Medical staff #1		
Obsessive behavior			3	Cardiologist #3		
Privacy			2	Healthcare provider #1 Medical staff #1		
Quality and timeliness of contact			5	Cardiologist #1 Medical staff #1		
Lack of face to face contact			2	Cardiologist #1 Medical staff #1		
Forgot to measure			1	eHealth expert #1		
Technical issues			6	Cardiologist #1 eHealth expert #2 Healthcare provider #2 Medical staff #1		
Technical skills			5	Cardiologist #1 eHealth expert #2 Healthcare provider #2		
Afraid they cannot use it			3	eHealth expert #2 Healthcare provider #1		
Technology not in line with patient wishes			1	Cardiologist #1		
Unsafe feeling when training from home			1	eHealth expert #1		
Physical activity	1	Medical staff #1			1	Cardiologist #1

The Effects of Telehomecare as Experienced by Healthcare Professionals

Despite the telehomecare effects experienced by patients, healthcare professionals have also both positive and negative experiences when using telehomecare. The (dis)advantages they identified are shown in Table 9. One of the aspects which is experienced as both positive and negative by the healthcare professionals is the changing role of healthcare due to telehomecare. For example:

> *"[…] they [patients] were very happy with it [telehomecare], because cardiologists don't want to do this, it is not what they were trained for. They were fine with it, then I can do heart surgeries, which I like best." (eHealth expert #1)*

> *"Occasionally, nurses have the feeling that they are a police officer, for example, why did the patient not measure today? […] if you are a nurse who prefers hands-on work, than you will like the new way of working less." (cardiologist #1)*[6]

Efficiency caused by telehomecare led to various experiences. More efficiency due to less work, less healthcare utilizations and a better deployment of staff were experienced. However, other participants mentioned that telehomecare led to more work instead of less.

Additionally, many participants mentioned that the availability of better patient data gives healthcare professionals an increased feeling of security, which enables them to take more appropriate and adequate actions in relation to patients' health:

> *"[…] a feeling of security for the professional, if you don't get a notification, you know it is okay." (healthcare provider #2)*

[6] This was the case in the start-up phase of the telehomecare project. Now the protocols have changed and it is less experienced like that.

Lastly, negative experiences with regards to the quality of data, and therefore the responsibility, were encountered. Additionally, healthcare professionals encountered technical issues regarding telehomecare, as well as problems regarding technical skills.

Table 9. The Effects of Telehomecare Experienced by Healthcare Professionals

	Positive effect mentioned by # participants	**Role (number of participants)**	**Negative effect mentioned by # participants**	**Role (number of participants)**
Changing role in healthcare	5	Cardiologist #3 Medical staff #1 eHealth expert #1	7	Cardiologist #3 Healthcare provider #3 Medical staff #1
Efficiency				
Less work	1	Healthcare provider #1	2	Cardiologist #1 eHealth expert #1
Less healthcare utilization	3	Cardiologist #1 Healthcare provider #1 eHealth expert #1		
Staff deployment	2	Healthcare provider #1, eHealth expert #1		
Changing processes			1	Healthcare provider #1
More or better patient information	9	Cardiologist #2 Medical staff #2 Healthcare provider #3 eHealth expert #2		
Issues with quality and responsibility			4	Cardiologist #1 eHealth expert #2 Medical staff #1
Technical issues			2	Cardiologist #1 eHealth expert #1
Technical skills			2	Medical staff #1 Healthcare provider #1

The Effects of Telehomecare Experienced by Healthcare Organizations

The effects of telehomecare as experienced by healthcare organizations are mentioned in terms of costs, as shown in Table 10. From the interviews, it seems that savings are probably linked to the efficiency that healthcare organizations experience:

"Reduction in poli[clinic] visits, days in the hospital, etc. We also did a calculation on the costs together with a health insurer. […]. So we have done some research, with very positive results." (healthcare provider #3).

Table 10. The Effects of Telehomecare Experienced by Healthcare Organizations

	Positive effect mentioned by # participants	Role (number of participants)	Negative effect mentioned by # participants	Role (number of participants)
Effect on costs	3	Cardiologist #1 eHealth expert #1 Healthcare provider #1	3	Cardiologist #1 Healthcare professional #1 Healthcare provider #1
Healthcare utilization	1	Cardiologist #1		

The Effects of Telehomecare Experienced by Caregivers

Our participants mentioned that not only patients, healthcare professionals, and healthcare organizations notice the advantages of telehomecare, caregivers experience them as well. As shown in Table 11 participants noted that they appreciate the increased convenience which is enabled by telehomecare. This is also explained by a healthcare provider in the following quote:

"A lot of people [patients] are dependent on children and neighbors to get to the hospital. See what this brings, in convenience and less hassle." (healthcare provider #2)

Additional, the participants mentioned that caregivers also experience time-efficiency. Furthermore, the caregiver can be more involved because they have more insight in the measured vital data of the patient, and therefore know more about the patient's health condition.

Table 11. The Effects of Telehomecare Experienced by Caregivers

	Positive effect mentioned by # participants	Role (number of participants)	Negative effect mentioned by # participants	Role (number of participants)
Experienced convenience	2	Healthcare provider #1 eHealth expert #1		
Time-efficiency	1	Healthcare provider #1		
Involved caregiver	1	Healthcare provider #1		

7.4. Discussion

Main Findings

The objective of this study was to examine the positive and negative outcomes of telehomecare for patients, healthcare professionals, and healthcare providers in the Netherlands. We also tried to increase the data's meaning of our findings by describing the experience of the participants.

In the research both positive and negative experiences with telehomecare are described from different perspectives. Outcomes that go beyond what was found in the literature studies are also mentioned in the interviews, which could be of interest for looking into the added value of telehomecare. These additional experiences and outcomes give more meaning to the data and supplement the SLR and meta-analysis.

Added Value of Telehomecare for Patients

Our result showed many outcomes that serve as insights of the experiences of patients. Many of these outcomes were not found in the earlier performed SLR and meta-analysis, such as the advantages of telehomecare related to up-titration and having more information about patients (which can be helpful for creating a more suitable care plan). Although not resulting from the literature study performed in this thesis, the result of more and better patient information and the possible role of telehomecare for medication up-titration are found in different literature studies. [97-99]

The positive outcomes that were mentioned in the interviews are a decrease in hospital utilization, and improved patient compliance, patient satisfaction, self-rated health status, and QoL, confirming the results of Paré[100] However, the last mentioned outcome contradicts with the findings of Rojas,[91] who describes that telehomecare does not improve the QoL.

Additionally, our participants found an increase in the patient's physical activity and a decrease in ED visits, re-admissions, and length of stay, confirming the results of Inglis,[1] Dansky,[32] and Benatar.[101] Previous studies showed that patients are less likely to seek care at the ED if a healthcare provider follows their clinical data.[101] This gives the patient an increased feeling of safety, which confirms the results found in the interviews. Additionally, we found that the patients experience more personalized care which is more tailored to their specific health situation due to the use of telehomecare. This confirms the results of Boyne[103] and Fairbrother.[104]

Negative outcomes, such as privacy issues and patients' demonstration of obsessive behavior, were mentioned by our participants. These results on privacy were not found in the previous studies. However, in other studies it is described that although the initial fee of some patients was privacy, this seems to be diminish after using it for a while.[7]

Although the reassurance caused by telehomecare was mentioned earlier,[103] our participants found that telehomecare caused an increased burden on the patient, for example by causing an unsafe feeling, This in turn was caused by telehomecare as it made their home an extended healthcare institution.[108, 109]

Additional negative experiences with telehomecare were mentioned by our participants in terms of technical issues and the technical skill level of the patient, confirming the results of Creswell[104] and Boyne.[108]

Some results are only mentioned a few times during the interviews and therefore seem less important than other aspects. However, it is noteworthy to mention that previous studies did not found the following findings: the quality and timeliness of the contact between patient and healthcare professional, the unsafe feeling experienced by the patient when training from home, and lastly, the patients' lack of motivation to use telehomecare.

Added Value of Telehomecare for Healthcare Professionals

Our interviews provide in-depth information on the added value as experienced by healthcare professionals. As such, the changing role in healthcare is mentioned, which is both experienced as a positive and negative change for healthcare professionals. The acceptance of the new role due to telehomecare is relatively high, confirming the results of Gagnon.[33] However, negative experiences with a changing role for healthcare professionals are confirmed in the literature, such as a fear to lose power, or the fear to become redundant.[108]

The participants mentioned that the efficiency of healthcare professionals' did increase due to telehomecare. However, the level of efficiency is disputed in the interviews, and depends on the way telehomecare is provided.[90] In the literature a gap does exist on if and how telehomecare can be efficient.[110] The last advantage of telehomecare experienced by healthcare professionals is that more and better patient information is available, confirming the results found in the study by Radhakrishnan.[77]

As for the negative aspects, our participants were concerned about the quality and responsibility of telehomecare. These concernes were also experienced by Chang.[110] Additionally, our participants mentioned issues with technology. These findings are consistent with the findings of Fairbrother,[104] who mentioned that the complexity of technology can be frustrating and anxiety provoking. Lastly, examples of personnel that refuses to use telehomecare are given in the interviews, which is might be due to a lack of knowledge on how to operate the system, confirming the results of Boyne.[108]

Added Value of Telehomecare for Healthcare Organizations

In relation to the added value for healthcare organizations, our participants only mentioned costs, and the effect of healthcare utilization on costs. They believe that telehomecare positively affects hospitals' expenses by reducing the healthcare utilization of patients, which has an impact on total expenses. However, it is also mentioned to be a burden on the healthcare costs. Previous studies showed that telehomecare is cost effective, however, the cost-effectiveness may differ due to the different countries in which it was performed.[74, 79]

Caregivers

Our results showed that the caregivers experienced more convenience in dealing with the patient's health. This increased convenience is due to less healthcare utilization, resulting in more available time. Additionally, it was mentioned in our interviews that telehomecare provides the caregiver with more data insight, enabling more involvement for the caregiver with the patient.

To the best of our knowledge, no previous study confirms or disconfirms our findings. However the study of Scott[81] found different negative experiences, such as the financial burden, social confinement, and psychological distress experienced by caregivers.

Implications

It is expected that this study will mainly have implications for healthcare providers; however, healthcare professionals and patients can benefit from the results as well. Healthcare providers will encounter the positive results by becoming aware of how healthcare professionals and providers experience telehomecare. Having knowledge on the experiences of healthcare professionals and providers will likely enable providers to understand how the healthcare professionals who will use the technology might experience telehomecare. This can in turn support healthcare organizations when they are deciding how to best implement the technology in the healthcare process.

Beyond having implications for healthcare organizations, this qualitative study also offers benefits to suppliers by providing additional knowledge on the experiences of healthcare professionals and patients using telehomecare. This knowledge offers more insights into healthcare professionals' experiences and therefore also into the technical issues that the participants encounter. Being aware of these experiences when developing telehomecare projects could probably help suppliers to achieve better usability and technical robustness.[96, 101] Improving the usability and technical robustness will ensure that patients and healthcare professionals have less negative experiences with telehomecare, and can therefore increase the use of telehomecare.

Limitations

Finally, this qualitative study has some limitations. It is possible that because of the exclusion of patients direct input on patients' experiences with telehomecare is missing. It was therefore not possible to give a complete overview on the added value of telehomecare as experienced by all parties. However, the patient's perspective is discussed in the SLR and meta-analysis, and additionally obtained from the experiences of the participants. Nevertheless, it would be interesting for a future qualitative study to investigate the added value of telehomecare as experienced by patients.

Lastly, the inclusion of 15 respondents in the qualitative study was limited. Additionally, non-believers and non-users were not included in the interviews ample. It could therefore be that different experiences and opinions are not included into this qualitative research. It is thus recommended that a further qualitative study be conducted with a larger sample size to see whether participants mention different outcomes.

8. Discussion

This thesis examined the added value of telehomecare for heart patients, healthcare professionals, and healthcare organizations, both worldwide and in the Netherlands. The added value was investigated through an SLR, meta-analysis, and semi-structured interviews to answer the following main research question:

"What is the added value of telehomecare for heart patients, healthcare professionals, and healthcare organizations?"

Main findings

Telehomecare Devices

The devices that are most commonly used with telehomecare for CVD were researched in an SLR. Two different CVDs were investigated: CAD and CHF.

In the literature on telehomecare for CAD patients, the most frequently used devices are ECG devices and BPDs. For CHF patients, weight scales and BPD are most common; this combination of devices is also the most often occurring for both diseases. Although in the literature it is mentioned that these devices are used for CAD and CHF patients,[41] no literature is found which describes which the most frequently occurring devices are.

Patients

Both positive and negative outcomes on the added value of telehomecare were found through all of the research methods that were used in this thesis. However, it is noteworthy that almost all positive and negative outcomes of the SLR and meta-analysis, were also mentioned in the interviews.

The following outcomes were both identified in the quantitative research as in the interviews: health condition,[51, 54, 70, 111, 112, 113] healthcare utilization,[67, 114, 115, 116] medical intake[50, 55, 56, 60, 67, 69, 70, 117, 118] psychological condition,[119] re-admission,[51, 61, 69, 70, 72, 117, 120] QoL,[52, 68, 115, 121] ED visits,[23, 53, 54, 56, 64, 122] health perception,[56, 62, 69] LoS,[31, 50, 53, 72, 117, 122] self-care.[68, 113, 116, 119, 129] Hospitalization,[31, 32, 61, 64, 118, 127] and mortality,[50, 51, 52, 55, 61, 64, 69, 72, 123] were mentioned in the quantitative research but not in the interviews.

However, this is not the case the other way around; the interviews did provide many additions to the positive and negative outcomes measured in the SLR and meta-analysis: time-efficiency, feeling of safety,[102] health confidence, more and better patient information,[97-99] patient involvement, patient compliance,[100] satisfaction with care,[100] tailored care,[103], burden of telehomecare,[103] lack of motivation, obsessive behavior, privacy, uptitration,[97-99] technical issues, [102] and technical skills.[104]

These additional outcomes seem to show that it is not possible to predict which outcomes will be important in practice. As such, the interviews appear to be a good supplement to the SLR and meta-analysis by providing the context of telehomecare. This context is described through information on often-mentioned themes and insights into certain outcomes (such as demographic characteristics) that seem to have causal relationships.

Healthcare Professionals

A finding from the literature review and interviews is that healthcare professionals have a positive perception of the use of telehomecare; however, the literature does not mention what they experience as added value. This was discussed in more detail in the interviews, where participants commented on positive experiences with their changing role in healthcare,[33] increased efficiency, and more or better patient information.[77] The increased level of efficiency is disputed in the interviews, and seems to depend on the way telehomecare is provided.[89]

Negative outcomes experienced by healthcare professionals were only mentioned during the interviews: a changing role and method of working,[103] issues with quality and responsibility, [110] technical issues,[100] and a lack of technical skills.[103] These results confirm those reported by Jaarsma,[98] which describe professionals' concerns regarding patient dependency on practitioner support, an increased workload, and the need for improved technology. It is remarkable that additional outcomes were found in the current qualitative study and that even more negative outcomes are mentioned by Cleland[76] and Boyne,[108] which indicates that additional qualitative research on this subject is merited.

Healthcare Organizations

The SLR and meta-analysis revealed that telehomecare can increase the cost-effectiveness of healthcare. The participants noted varying opinions, saying it is either cost-effective or a burden on healthcare costs. Although telehomecare requires an initial financial investment, Inglis[74] and Seto[79] find it to be cost effective. The results of the literature may differ from the interviews, because the studies are conducted in different countries.

Caregivers

The effects of telehomecare experienced by caregivers were not included in the research questions. However, the added value for caregivers is discussed in both the literature review and the interviews, mostly in terms of time-efficiency. The negative experiences are also mentioned in the SLR, however, the included literature does not elaborate on which negative experiences are encountered by the caregivers. However, in Scott,[81] more negative experiences are identified, such as financial burden, social confinement, and psychological distress.

Beyond a few studies, almost no research has been done to investigate the caregivers' experiences with telehomecare. It is therefore recommended that more research be undertaken to extend to the knowledge relating to this subgroup.

Conclusions

The qualitative study added much information to the quantitative study, especially in terms of outcomes for healthcare professionals and caregivers. It is mentioned by Kaplan[130] that multiple methods enable different kinds of data to be collected and thus help to form a complete picture, thereby strengthening the robustness of a study's results. It is therefore expected that conducting a more extensive qualitative study would yield even more outcomes for caregivers and healthcare professionals.

Implications

Implications for Practice

Compared to usual conventional care, the implementation of non-invasive telehomecare has positive influences on, among others, mortality, re-admission, hospitalization, and LoS. It should therefore be considered as a strategy for improving the quality of care for people with CVD.

The interview results also indicate that healthcare organizations are insufficiently included in the telehomecare process. However, this study identifies multiple advantages for this group. It is therefore important that its findings are translated into practice and that these parties also both included in the telehomecare process and made aware of its value in relation to CVD.

Implications for Research

As mentioned above, the preferences and engagements of patients, healthcare professionals, healthcare organizations, and caregivers are key for the success of telehomecare. As such, they should be focused on more in future research.

Limitations

The quantitative study investigated the added value of telehomecare for three diseases (CAD, cardiac arrhythmia, and CHF); however, this distinction is not made in the qualitative study. It would therefore be interesting to use both types of studies to investigate the added value for each disease.

Almost all outcomes resulting from the quantitative study are focust on the added value of telehomecare for patients. If the included literature did mention added value for healthcare professionals, healthcare organizations and caregivers, it was often not further specified. In the interviews more in-depth results were found for these specific roles. However, the differences in the found results made it difficult to compare the outcomes of the quantitative-, and qualitative research. Therefore future research, both qualitative as quantitative, is recommended on the added value of telehomecare for healthcare professionals, healthcare organizations and caregivers.

References

Articles included in the SLR are indicated by an asterisk (*). Articles included into the meta/ analysis are indicated with two asterisk (**)

1. Inglis SC, Clark RA, Dierckx R, Prieto-Merino D, Cleland JGF. Structured telephone support or non-invasive telemonitoring for patients with heart failure. Cochrane database Syst Rev. 2015;10(10):CD007228.

2. *Cardiac Medications*. (2017). *Heart.org*. Retrieved 20 July 2017, from http://www.heart.org/HEARTORG/Conditions/HeartAttack/TreatmentofaHeartAttack/Cardiac-Medications_UCM_303937_Article.jsp#.WXDlNcaiGRs

3. *Cardiac Event Recorder*. (2017). *Heart.org*. Retrieved 20 July 2017, from http://www.heart.org/HEARTORG/Conditions/Arrhythmia/PreventionTreatmentofArrhythmia/Cardiac-Event-Recorder_UCM_447317_Article.jsp#.WXDJ-8aiGRs

4. Brown J, Gray CS. Stemming the tide of readmissions: Patient, practice or practitioner? Rev Clin Gerontol [Internet]. 1998;8(2):173–81. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=emed4&AN=1998263329%5Cnhttp://sfx.unimaas.nl:9003/sfx_local/?sid=OVID:embase&id=pmid:&id=doi:10.1017%252FS0959259898008284&issn=0959-2598&isbn=&volume=8&issue=2&spage=173&pages=173-181&d

5. Kato N, Ito N, Kinugawa K, Kazuma K. Validity and reliability of the Japanese version of the European Heart Failure Self-Care Behavior Scale. Eur J Cardiovasc Nurs. 2008;7(4): 284–9.

6. Kamat V. Pulse oximetry. Indian J Anaesth. 2002;46(4):261–8.

7. Demiris G, Speedie SM, Finkelstein S. Change of patients' perceptions of TeleHomeCare. Telemed J E Health. 2001;7(3):241–8.

8. Blokstra a., Verschuren WMM (Red. ., Baan C a., Boshuizen HC, Feenstra TL, Hoogenveen RT, et al. Vergrijzing en toekomstige ziektelast: Prognose chronische ziektenprevalentie 2005-2025. 2007;1–98.

9. Van der Horst A, Van Erp F, De Jong J. Trends in gezondheid en zorg. Cent Planbur [Internet]. 2011;3–13. Available from: http://www.cpb.nl/publicatie/trends-in-gezondheid-en-zorg

10. De Hollander, Hoeymans N, Melse J.M., Van Oers JAM, Polder JJ. Zorg voor gezondheid. Volksgezondheid Toekomst Verkenning 2006. 2006.

11. Peeters, J., Friele, R., De Bie, J. & Wiegers T. Technologie in de zorg thuis. 2016.

12. Sood S, Mbarika V, Jugoo S, Dookhy R, Doarn CR, Prakash N, et al. What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings. Telemed J E Health. 2007 Oct;13(5):573–90.

13. de Vries AE, van der Wal MH, Bedijn W, de Jong RM, van Dijk RB, Hillege HL, et al. Follow-up and treatment of an instable patient with heart failure using telemonitoring and a computerised disease management system: a case report. Eur J Cardiovasc Nurs. 2012 Dec; 11(4):432–8.

14. Bashi N, Karunanithi M, Fatehi F, Ding H, Walters D. Remote Monitoring of Patients With Heart Failure: An Overview of Systematic Reviews. J Med Internet Res. 2017 Jan;19(1):e18.

15. Bots ML, Buddeke, Dis I Van, Vaartjes I, Vissseren FLJ. Hart- en vaatziekten in Nederland 2015. Centrum [Internet]. 2015;132. Available from: http://www.hartstichting.nl/9800/13341/15305/HVZ_in_Nederland_2010

16. Lameire N, Joffe P, Wiedemann M. Healthcare systems--an international review: an overview. Nephrol Dial Transplant. 1999;14 Suppl 6:3–9.

17. RIVM. (2014). *Trends in de volksgezondheid - RIVM*. Retrieved 25 January 2017, from http://www.eengezondernederland.nl/Een_gezonder_Nederland/Highlights/Trends_in_de_volksgezondheid

18. WHO. Integrated chronic disease prevention and control [Internet]. 2010. Available from: http://www.who.int/chp/about/integrated_cd/en/

19. WHO. Cardiovascular diseases (CVDs) [Internet]. 2016. Available from: http://www.who.int/mediacentre/factsheets/fs317/en/

20. What is Cardiovascular Disease? [Internet]. Heart.org. 2017 [cited 28 July 2017]. Available from: http://www.heart.org/HEARTORG/Caregiver/Resources/WhatisCardiovascularDisease/What-is-Cardiovascular-Disease_UCM_301852_Article.jsp#.WK7-MBhx-Rs

21. Stroke Association. How cardiovascular & stroke risk relate [Internet]. 2017. Available from: http://www.strokeassociation.org/STROKEORG/LifeAfterStroke/HealthyLivingAfterStroke/UnderstandingRiskyConditions/How-Cardiovascular-Stroke-Risks-Relate_UCM_310369_Article.jsp#.WO9CZmnygdU

22. Research Agenda Topics [Internet]. Hartstichting.nl. 2017 [cited 28 July 2017]. Available from: https://www.hartstichting.nl/downloads/research-agenda-topics

23. ** Davis C, Bender M, Smith T, Broad J. Feasibility and Acute Care Utilization Outcomes of a Post-Acute Transitional Telemonitoring Program for Underserved Chronic Disease Patients. Telemed J E Health. 2015 Sep;21(9):705–13.

24. RIVM. Levensverwachting stijgt, maar verschillen tussen sociaaleconomische groepen zijn groot [Internet]. 2014. Available from: http://www.eengezondernederland.nl/Een_gezonder_Nederland/Highlights/Trends_in_de_volksgezondheid

25. Volksgezondheid en Zorg. Ziektelast in DALY's. Available from: https://www.volksgezondheidenzorg.info/ziektelast-nederland#!node-ziektelast-naar-groepen-van-ziekten

26. Murray CJ, Lopez AD. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. Lancet (London, England). 1997 May;349(9063):1436–42.

27. Ursum J, Rijken M, Heijmans M, Cardol M, Schellevis F. NIVEL Overzichtstudies: zorg voor chronisch zieken: organisatie van zorg, zelfmanagement, zelfredzaamheid en participatie. 2011;

28. Hart- en vaatziekten | Kosten | Kosten | Volksgezondheidenzorg.info [Internet]. Volksgezondheidenzorg.info. 2017 [cited 28 July 2017]. Available from: https://www.volksgezondheidenzorg.info/onderwerp/hart-en-vaatziekten/kosten/kosten#!node-kosten-van-zorg-voor-hart-en-vaatziekten

29. Lorig KR, Sobel DS, Ritter PL, Laurent D, Hobbs M. Effect of a self-management program on patients with chronic disease. Eff Clin Pract. 2001;4(6):256–62.

30. Jaarsma, T., Cameron, J., Riegel, B., & Stromberg, A. (2017). Factors Related to Self-Care in Heart Failure Patients According to the Middle-Range Theory of Self-Care of Chronic Illness: a Literature Update. Current Heart Failure Reports, 14(2), 71–77. https://doi.org/10.1007/s11897-017-0324-1

31. * Bakhshi S, Li X, Semenov N, Apodaca-Madrid J, Mahoor MH, Newman KE, et al. Congestive Heart Failure home monitoring pilot study in urban Denver. Conf Proc IEEE Eng Med Biol Soc [Internet]. 2011;2011:3150–3. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84862605619&partnerID=40&md5=6b8deb972715e2444faf60b302a6d17c

32. * Dansky KH, Vasey J, Bowles K. Impact of telehealth on clinical outcomes in patients with heart failure. Clin Nurs Res. 2008 Aug;17(3):182–99.

33. Gagnon MP, Orruno E, Asua J, Abdeljelil A Ben, Emparanza J. Using a modified technology acceptance model to evaluate healthcare professionals' adoption of a new telemonitoring system. Telemed J E Health. 2012;18(1):54–9.

34. Oudshoorn N. Diagnosis at a distance: the invisible work of patients and healthcare professionals in cardiac telemonitoring technology. Sociol Health Illn. 2008 Mar;30(2):272–88.

35. Inglis C, Clark RA, McAlister FA, Stewart S, Cleland JGF. Which components of heart failure programmes are effective? A systematic review and meta-analysis of the outcomes of structured telephone support or telemonitoring as the primary component of chronic heart failure management in 8323 patients: Abridged Coc. Eur J Heart Fail. 2011 Sep;13(9):1028–40.

36. Schers H. Gunstig effect van telehealth. Huisarts Wet [Internet]. 2012;55(11):484. Available from: http://dx.doi.org/10.1007/s12445-012-0243-z

37. Ranglijst ziekten op basis van prevalentie | Volksgezondheidenzorg.info [Internet]. Volksgezondheidenzorg.info. 2017 [cited 28 July 2017]. Available from: https://www.volksgezondheidenzorg.info/ranglijst/ranglijst-ziekten-op-basis-van-prevalentie

38. Coyne JC, Hagedoorn M, Thombs B. Most published and unpublished dissertations should be excluded from meta−analyses: comment on Moyer et al. Psycho−Oncology. 2011;20(2): 224–5.

39. Classes of Heart Failure. (2017). Heart.org. Retrieved 16 May 2017, from http://www.heart.org/HEARTORG/Conditions/HeartFailure/AboutHeartFailure/Classes-of-Heart-Failure_UCM_306328_Article.jsp#.WRsOG2nygdU

40. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009 Jul;339:b2700.

41. Yilmaz T, Foster R, Hao Y. Detecting vital signs with wearable wireless sensors. Sensors. 2010;10(12):10837–62.

42. Maric B, Kaan A, Ignaszewski A, Lear SA. A systematic review of telemonitoring technologies in heart failure. Eur J Heart Fail [Internet]. 2009;11(5):506–17. Available from: https://www.scopus.com/inward/record.uri?eid=2-

s2.0-66249095957&doi=10.1093%2Feurjhf%2Fhfp036&partnerID=40&md5=15f5a16e26ee2b44de74d55d277b9a40

43. Domingo M, Lupon J, Gonzalez B, Crespo E, Lopez R, Ramos A, et al. Evaluation of a telemedicine system for heart failure patients: feasibility, acceptance rate, satisfaction and changes in patient behavior: results from the CARME (CAtalan Remote Management Evaluation) study. Eur J Cardiovasc Nurs. 2012 Dec;11(4):410–8.

44. Anker SD, Koehler F, Abraham WT. Telemedicine and remote management of patients with heart failure. Lancet. 2011;378(9792):731–9.

45. Bikdeli B, Wayda B, Bao H, Ross JS, Xu X, Chaudhry SI, et al. Place of Residence and Outcomes of Patients With Heart Failure. Circ Cardiovasc Qual Outcomes. 2014;7(5):749–56.

46. Ranglijst ziekten op basis van prevalentie | Volksgezondheidenzorg.info [Internet]. Volksgezondheidenzorg.info. 2017 [cited 28 July 2017]. Available from: https://www.volksgezondheidenzorg.info/ranglijst/ranglijst-ziekten-op-basis-van-prevalentie

47. *Cochrane Handbook for Systematic Reviews of Interventions | Cochrane Training [Internet]. Handbook.cochrane.org. 2017 [cited 28 July 2017]. Available from:* http://Handbook.cochrane.org/chapter_9/9_4_4_1_mantel_haenszel_methods.htm

48. *Cochrane Handbook for Systematic Reviews of Interventions | Cochrane Training [Internet]. Handbook.cochrane.org. 2017 [cited 28 July 2017]. Available from:* http://Handbook.cochrane.org/chapter_9/9_4_5_1_which_measure_for_continuous_outcomes.htm

49. ** Bowles KH, Riegel B, Weiner MG, Glick H, Naylor MD. The effect of telehomecare on heart failure self care. AMIA . Annu Symp proceedings AMIA Symp. 2010 Nov;2010:71–5.

50. ** Dendale P, De Keulenaer G, Troisfontaines P, Weytjens C, Mullens W, Elegeert I, et al. Effect of a telemonitoring-facilitated collaboration between general practitioner and heart failure clinic on mortality and rehospitalization rates in severe heart failure: the TEMA-HF 1 (TElemonitoring in the MAnagement of Heart Failure) study. Eur J Heart Fail [Internet]. 2012;14(3):333–40. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84862318820&doi=10.1093%2Feurjhf%2Fhfr144&partnerID=40&md5=e800858797c703911071a73f9a832149

51. ** Giordano A, Scalvini S, Zanelli E, Corra U, Longobardi GL, Ricci VA, et al. Multicenter randomised trial on home-based telemanagement to prevent hospital readmission of patients with chronic heart failure. Int J Cardiol. 2009 Jan;131(2):192–9.

52. ** Koehler F, Winkler S, Schieber M, Sechtem U, Stangl K, Bohm M, et al. Impact of remote telemedical management on mortality and hospitalizations in ambulatory patients with chronic heart failure: the telemedical interventional monitoring in heart failure study. Circulation. 2011 May;123(17):1873–80.

53. ** Morguet AJ, Kuhnelt P, Kallel A, Jaster M, Schultheiss H-P. Impact of telemedical care and monitoring on morbidity in mild to moderate chronic heart failure. Cardiology. 2008;111(2):134–9.

54. ** Dar O, Riley J, Chapman C, Dubrey SW, Morris S, Rosen SD, et al. A randomized trial of home telemonitoring in a typical elderly heart failure population in North West London: results of the Home-HF study. Eur J Heart Fail. 2009 Mar;11(3):319–25.

55. ** Dierckx R, Cleland JG, Pellicori P, Zhang J, Goode K, Putzu P, et al. If home telemonitoring reduces mortality in heart failure, is this just due to better guideline-based treatment? J Telemed Telecare. 2015 Sep;21(6):331–9.

56. ** Villani A, Malfatto G, Compare A, Della Rosa F, Bellardita L, Branzi G, et al. Clinical and psychological telemonitoring and telecare of high risk heart failure patients. J Telemed Telecare. 2014 Dec;20(8):468–75.

57. ** Bowles KH, Hanlon AL, Glick HA, Naylor MD, O'Connor M, Riegel B, et al. Clinical effectiveness, access to, and satisfaction with care using a telehomecare substitution intervention: a randomized controlled trial. Int J Telemed Appl. 2011;2011:12.

58. ** Chaudhry S., Mattera J., Curtis J., Spertus J., Herrin J., Lin Z., Phillips C., Hodshon B., Cooper L. KH. Telemonitoring in Patients with Heart Failure. N Engl J Med. 2010;363(24): 2301–9.

59. ** Kraai I, de Vries A, Vermeulen K, van Deursen V, van der Wal M, de Jong R, et al. The value of telemonitoring and ICT-guided disease management in heart failure: Results from the IN TOUCH study. Int J Med Inform. 2016 Jan;85(1):53–60.

60. ** Frederix I, Van Driessche N, Hansen D, Berger J, Bonne K, Alders T, et al. Increasing the medium-term clinical benefits of hospital-based cardiac rehabilitation by physical activity telemonitoring in coronary artery disease patients. Eur J Prev Cardiol. 2015 Feb;22(2):150–8.

61. ** Waldmann A, Katalinic A, Schwaab B, Richardt G, Sheikhzadeh A, Raspe H. The TeleGuard trial of additional telemedicine care in CAD patients. 2 Morbidity and mortality after 12 months. J Telemed Telecare. 2008;14(1):22–6.

62. ** Pedone C, Rossi FF, Cecere A, Costanzo L, Antonelli Incalzi R. Efficacy of a Physician-Led Multiparametric Telemonitoring System in Very Old Adults with Heart Failure. J Am Geriatr Soc. 2015 Jun;63(6):1175–80.

63. ** Soran OZ, Feldman AM, Piña IL, Lamas GA, Kelsey SF, Selzer F, et al. Cost of medical services in older patients with heart failure: Those receiving enhanced monitoring using a computer-based telephonic monitoring system compared with those in usual care: The heart failure home care trial. J Card Fail [Internet]. 2010;16(11):859–66. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-78149285499&doi=10.1016%2Fj.cardfail.2010.05.028&partnerID=40&md5=7669fd6a2b004f690d2b71f7377bfa20

64. ** Wade MJ, Desai AS, Spettell CM, Snyder AD, McGowan-Stackewicz V, Kummer PJ, et al. Telemonitoring with case management for seniors with heart failure. Am J Manag Care. 2011 Mar;17(3):e71-9.

65. ** Soran OZ, Piña IL, Lamas GA, Kelsey SF, Selzer F, Pilotte J, et al. A Randomized Clinical Trial of the Clinical Effects of Enhanced Heart Failure Monitoring Using a Computer-Based Telephonic Monitoring System in Older Minorities and Women. J Card Fail [Internet]. 2008;14(9):711–7. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-55149110118&doi=10.1016%2Fj.cardfail.2008.06.448&partnerID=40&md5=441942dd49b498dc309efbe9ad63a9e8

66. ** Pekmezaris R, Mitzner I, Pecinka KR, Nouryan CN, Lesser ML, Siegel M, et al. The impact of remote patient monitoring (telehealth) upon Medicare beneficiaries with heart failure. Telemed J E Health [Internet]. 2012;18(2):101–8. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84863563402&partnerID=40&md5=f2214a602c58f407f1713fd68fd73f80

67. ** Vuorinen A-L, Leppanen J, Kaijanranta H, Kulju M, Helio T, van Gils M, et al. Use of home telemonitoring to support multidisciplinary care of heart failure patients in Finland: randomized controlled trial. J Med Internet Res. 2014 Dec;16(12):e282.

68. ** Seto E, Leonard KJ, Cafazzo JA, Barnsley J, Masino C, Ross HJ. Mobile phone-based telemonitoring for heart failure management: a randomized controlled trial. J Med Internet Res [Internet]. 2012;14(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84860559123&doi=10.2196%2Fjmir.1909&partnerID=40&md5=f890f8658cb4ee1fb03eda0f5348463c

69. ** Antonicelli R, Testarmata P, Spazzafumo L, Gagliardi C, Bilo G, Valentini M, et al. Impact of telemonitoring at home on the management of elderly patients with congestive heart failure. J Telemed Telecare. 2008;14(6):300–5.

70. ** Antonicelli R, Mazzanti I, Abbatecola AM, Parati G. Impact of home patient telemonitoring on use of β-blockers in congestive heart failure. Drugs and Aging [Internet]. 2010;27(10):801–5. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-77957727064&doi=10.2165%2F11538210-000000000-00000&partnerID=40&md5=9bc727a99771a879701ec555d4bd6a31

71. ** Perez-Rodriguez G, Brito-Zurita OR, Sistos-Navarro E, Benitez-Arechiga ZM, Sarmiento-Salazar GL, Vargas-Lizarraga JF. [Telemetric monitoring reduces visits to the emergency room and cost of care in patients with chronic heart failure]. Cir Cir. 2015;83(4): 279–85.

72. ** Sohn S, Helms TM, Pelleter JT, Müller A, Kröttinger AI, Schöffski O. Costs and benefits of personalized healthcare for patients with chronic heart failure in the care and education program "Telemedicine for the Heart". Telemed J E Health [Internet]. 2012;18(3):198–204. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84864923633&partnerID=40&md5=b3d6aab3f4c9373211110c93473c6dec

73. McAlister FA, Lawson FME, Teo KK, Armstrong PW. Randomised trials of secondary prevention programmes in coronary heart disease: systematic review. Bmj. 2001;323(7319): 957–62.

74. Inglis SC, Clark RA, Dierckx R, Prieto-Merino D, Cleland JGF. Structured telephone support or non-invasive telemonitoring for patients with heart failure. Cochrane database Syst Rev. 2015;10(10):CD007228.

75. Kitsiou S, Paré G, Jaana M. Effects of home telemonitoring interventions on patients with chronic heart failure: an overview of systematic reviews. J Med Internet Res. 2015;17(3).

76. Cleland JGF, Louis AA, Rigby AS, Janssens U, Balk AHMM, Investigators T-H. Noninvasive home telemonitoring for patients with heart failure at high risk of recurrent admission and death: the Trans-European Network-Home-Care Management System (TEN-HMS) study. J Am Coll Cardiol. 2005;45(10):1654–64.

77. Radhakrishnan K, Jacelon C, Roche J. Perceptions on the Use of Telehealth by Homecare Nurses and Patients With Heart Failure: A Mixed Method Study. Home Heal Care Manag Pract [Internet]. 2012;24(4):175–81. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84864389043&doi=10.1177%2F1084822311428335&partnerID=40&md5=72e30fba36e44449c9068a5425ae72bd

78. Lindberg B, Nilsson C, Zotterman D, Söderberg S, Skär L. Using information and communication technology in home care for communication between patients, family members, and healthcare professionals: a systematic review. Int J Telemed Appl. 2013;2013.

79. Seto E. Cost comparison between telemonitoring and usual care of heart failure: a systematic review. Telemed e-Health. 2008;14(7):679–86.

80. Lindberg B, Nilsson C, Zotterman D, Söderberg S, Skär L. Using information and communication technology in home care for communication between patients, family members, and healthcare professionals: a systematic review. Int J Telemed Appl. 2013;2013.

81. Scott LD. Technological caregiving: a qualitative perspective. Home Health Care Manag Pract. 2001;13(3):227–35.

82. Artinian NT. Telehealth as a tool for enhancing care for patients with cardiovascular disease. J Cardiovasc Nurs. 2007;22(1):25–31.

83. Clark RA, Inglis SC, McAlister FA, Cleland JGF, Stewart S. Telemonitoring or structured telephone support programmes for patients with chronic heart failure: systematic review and meta-analysis. Bmj. 2007;334(7600):942.

84. Nationale Patienten Consumenten Federatie. Nationale Implementatieagenda e-Health [Internet]. The Hague: Nationale Patienten Consumenten Federatie; 2012. Available from: https://webcache.googleusercontent.com/search?q=cache:oCB1W1unPtMJ:https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2012/06/07/nationale-implementatieagenda-e-health-nia/nationale-implementatieagenda-e-health-nia.pdf+&cd=1&hl=nl&ct=clnk&gl=nl

85. De Hart&Vaatgroep: Telemonitoring [Internet]. Hartenvaatgroep.nl. 2017 [cited 27 July 2017]. Available from: http://www.hartenvaatgroep.nl/behandeling/ehealth/telemonitoring.html

86. Fossey E, Harvey C, McDermott F, Davidson L. Understanding and evaluating qualitative research. Aust N Z J Psychiatry. 2002;36(6):717–32.

87. Hunting G, Shahid N, Sahakyan Y, Fan I, Moneypenny CR, Stanimirovic A, et al. A multi-level qualitative analysis of Telehomecare in Ontario: challenges and opportunities. BMC Health Serv Res. 2015;15(1):544.

88. Philbin EF, DiSalvo TG. Influence of race and gender on care process, resource use, and hospital-based outcomes in congestive heart failure. Am J Cardiol. 1998;82(1):76–81.

89. * de Vries AE, van der Wal MHL, Nieuwenhuis MMW, de Jong RM, van Dijk RB, Jaarsma T, et al. Health professionals' expectations versus experiences of internet-based telemonitoring: survey among heart failure clinics. J Med Internet Res. 2013 Jan;15(1):e4.

90. Joseph V, West RM, Shickle D, Keen J, Clamp S. Key challenges in the development and implementation of telehealth projects. J Telemed Telecare. 2011;17(2):71–7.

91. Rojas SV, Gagnon M-P. A systematic review of the key indicators for assessing telehomecare cost-effectiveness. Telemed e-Health. 2008;14(9):896–904.

92. Lawson AE. What is the role of induction and deduction in reasoning and scientific inquiry? J Res Sci Teach. 2005;42(6):716–40.

93. Glaser BG, Strauss AL, Strutzel E. The discovery of grounded theory; strategies for qualitative research. Nurs Res. 1968;17(4):364.

94. Phillips L, Jorgensen MW. Discourse analysis as theory and method. Sage Publications London; 2002.

95. Douglas D. Grounded theories of management: a methodological review. Manag Res News. 2003;26(5):44–52.

96. Glaser BG, Strauss AL, Strutzel E. The discovery of grounded theory; strategies for qualitative research. Nurs Res. 1968;17(4):364.

97. Liddy C, Dusseault JJ, Dahrouge S, Hogg W, Lemelin J, Humber J. Telehomecare for patients with multiple chronic illnesses. Can Fam Physician. 2008;54(1):58–65.

98. Jaarsma T, Brons M, Kraai I, Luttik ML, Stromberg A. Components of heart failure management in home care; a literature review. Eur J Cardiovasc Nurs. 2013;12(3):230–41.

99. Kraai I, de Vries A, Vermeulen K, van Deursen V, van der Wal M, de Jong R, et al. The value of telemonitoring and ICT-guided disease management in heart failure: Results from the IN TOUCH study. Int J Med Inform. 2016 Jan;85(1):53–60.

100. Paré G, Jaana M, Sicotte C. Systematic review of home telemonitoring for chronic diseases: the evidence base. J Am Med Informatics Assoc. 2007;14(3):269–77.

101. Benatar D, Bondmass M, Ghitelman J, Avitall B. Outcomes of chronic heart failure. Arch Intern Med. 2003;163(3):347–52.

102. Pecina JL, Vickers KS, Finnie DM, Hathaway JC, Hanson GJ, Takahashi PY. Telemonitoring increases patient awareness of health and prompts health-related action: Initial evaluation of the TELE-ERA study. Telemed e-Health. 2011;17(6):461–6.

103.Boyne JJJ, Vrijhoef HJM, Spreeuwenberg M, De Weerd G, Kragten J, Gorgels APM. Effects of tailored telemonitoring on heart failure patients' knowledge, self-care, self-efficacy and adherence: a randomized controlled trial. Eur J Cardiovasc Nurs. 2014 Jun;13(3):243–52.

104.Fairbrother P, Ure J, Hanley J, McCloughan L, Denvir M, Sheikh A, et al. Telemonitoring for chronic heart failure: the views of patients and healthcare professionals - a qualitative study. J Clin Nurs. 2014 Jan;23(1–2):132–44.

105.Bowles KH, Baugh AC. Applying research evidence to optimize telehomecare. J Cardiovasc Nurs. 2007;22(1):5.

106.Creswell JW, Miller DL. Determining validity in qualitative inquiry. Theory Pract. 2000;39(3):124–30.

107.Prescher S, Deckwart O, Winkler S, Koehler K, Honold M, Koehler F. Telemedical care: feasibility and perception of the patients and physicians: a survey-based acceptance analysis of the Telemedical Interventional Monitoring in Heart Failure (TIM-HF) trial. Eur J Prev Cardiol. 2013 Jun;20(2 Suppl):18–24.

108.Boyne JJJ, Vrijhoef HJM. Implementing telemonitoring in heart failure care: barriers from the perspectives of patients, healthcare professionals and healthcare organizations. Curr Heart Fail Rep. 2013;10(3):254–61.

109.Oudshoorn N. How places matter: Telecare technologies and the changing spatial dimensions of healthcare. Soc Stud Sci [Internet]. 2012;42(1):121–42. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84855973307&doi=10.1177%2F0306312711431817&partnerID=40&md5=fcdb7440e82b11f1f97ea3bdeccd68dc

110.Chang J-Y, Chen L-K, Chang C-C. Perspectives and expectations for telemedicine opportunities from families of nursing home residents and caregivers in nursing homes. Int J Med Inform. 2009;78(7):494–502.

111.*Katalinic A, Waldmann A, Schwaab B, Richardt G, Sheikhzadeh A, Raspe H. The TeleGuard trial of additional telemedicine care in CAD patients. 1 Utilization of the system. J Telemed Telecare. 2008;14(1):17–21.

112.Ledwidge MT, O'Hanlon R, Lalor L, Travers B, Edwards N, Kelly D, et al. Can individualized weight monitoring using the HeartPhone algorithm improve sensitivity for clinical deterioration of heart failure? Eur J Heart Fail [Internet]. 2013;15(4):447–55. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84884479783&doi=10.1093%2Feurjhf%2Fhfs186&partnerID=40&md5=2b011f99af47b2d92d430972e04deb94

113.* Radhakrishnan K, Jacelon C, Roche J. Perceptions on the Use of Telehealth by Homecare Nurses and Patients With Heart Failure: A Mixed Method Study. Home Heal Care Manag Pract [Internet]. 2012;24(4):175–81. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84864389043&doi=10.1177%2F1084822311428335&partnerID=40&md5=72e30fba36e44449c9068a5425ae72bd

114.* Madigan E, Schmotzer BJ, Struk CJ, DiCarlo CM, Kikano G, Pina IL, et al. Home health care with telemonitoring improves health status for older adults with heart failure. Home Health Care Serv Q. 2013;32(1):57–74.

115.* Riley WT, Keberlein P, Sorenson G, Mohler S, Tye B, Ramirez AS, et al. Program evaluation of remote heart failure monitoring: healthcare utilization analysis in a rural regional medical center. Telemed J E Health. 2015 Mar;21(3):157–62.

116.* Keeping-Burke L, Purden M, Frasure-Smith N, Cossette S, McCarthy F, Amsel R. Bridging the transition from hospital to home: effects of the VITAL telehealth program on recovery for CABG surgery patients and their caregivers. Res Nurs Health. 2013 Dec;36(6):540–53.

117.* Domingo M, Lupon J, Gonzalez B, Crespo E, Lopez R, Ramos A, et al. Evaluation of a telemedicine system for heart failure patients: feasibility, acceptance rate, satisfaction and changes in patient behavior: results from the CARME (CAtalan Remote Management Evaluation) study. Eur J Cardiovasc Nurs. 2012 Dec;11(4):410–8.

118.* Radhakrishnan K, Bowles K, Hanlon A, Topaz M, Chittams J. A retrospective study on patient characteristics and telehealth alerts indicative of key medical events for heart failure patients at a home health agency. Telemed J E Health. 2013 Sep;19(9):664–70.

119.* Keeping-Burke L, Purden M, Frasure-Smith N, Cossette S, McCarthy F, Amsel R. Bridging the transition from hospital to home: effects of the VITAL telehealth program on recovery for CABG surgery patients and their caregivers. Res Nurs Health. 2013 Dec;36(6):540–53.

120.* Hoban MB, Fedor M, Reeder S, Chernick M. The effect of telemonitoring at home on quality of life and self-care behaviors of patients with heart failure. Home Healthc Nurse. 2013;31(7):368–77.

121.* Ammenwerth E, Woess S, Baumgartner C, Fetz B, van der Heidt A, Kastner P, et al. Evaluation of an Integrated Telemonitoring Surveillance System in Patients with Coronary Heart Disease. Methods Inf Med. 2015;54(5):388–97.

122.Tompkins C, Orwat J. A randomized trial of telemonitoring heart failure patients. J Healthc Manag. 2010;55(5):312–3.

123.* Bekelman DB, Plomondon ME, Carey EP, Sullivan MD, Nelson KM, Hattler B, et al. Primary Results of the Patient-Centered Disease Management (PCDM) for Heart Failure Study: A Randomized Clinical Trial. JAMA Intern Med. 2015 May;175(5):725–32.

124.* Chiang L-C, Chen W-C, Dai Y-T, Ho Y-L. The effectiveness of telehealth care on caregiver burden, mastery of stress, and family function among family caregivers of heart failure patients: a quasi-experimental study. Int J Nurs Stud. 2012 Oct;49(10):1230–42.

125.* Gambetta M, Dunn P, Nelson D, Herron B, Arena R. Impact of the implementation of telemanagement on a disease management program in an elderly heart failure cohort. Prog Cardiovasc Nurs [Internet]. 2007;22(4):196–200. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-38949201812&doi=10.1111%2Fj.0889-7204.2007.06483.x&partnerID=40&md5=80dcaab07cbceca42eb8c0f1b244d45b]

126.* Katalinic A, Waldmann A, Schwaab B, Richardt G, Sheikhzadeh A, Raspe H. The TeleGuard trial of additional telemedicine care in CAD patients. 1 Utilization of the system. J Telemed Telecare. 2008;14(1):17–21.

127.* Prescher S, Deckwart O, Winkler S, Koehler K, Honold M, Koehler F. Telemedical care: feasibility and perception of the patients and physicians: a survey-based acceptance analysis of the Telemedical Interventional Monitoring in Heart Failure (TIM-HF) trial. Eur J Prev Cardiol. 2013 Jun;20(2 Suppl):18–24.

128.* Radhakrishnan K, Bowles K, Hanlon A, Topaz M, Chittams J. A retrospective study on patient characteristics and telehealth alerts indicative of key medical events for heart failure patients at a home health agency. Telemed J E Health. 2013 Sep;19(9):664–70.

129.* Schwarz KA, Mion LC, Hudock D, Litman G. Telemonitoring of heart failure patients and their caregivers: a pilot randomized controlled trial. Prog Cardiovasc Nurs. 2008;23(1):18–26.

130.Kaplan B. Combining qualitative and quantitative methods in IS in healthcare revisited. E-Health Syst Diffus Use Innov User Use IT Model Innov User Use IT Model. 2005;198.

Appendices