Effect of Telehealth Interventions on Hospitalization Indicators: A Systematic Review

by Leila R. Kalankesh, PhD; Faramarz Pourasghar, MD, PhD; Lorraine Nicholson, FHRIM; Shamim Ahmadi; and Mohsen Hosseini

Abstract

Background: Telehealth has been defined as the remote delivery of healthcare services using information and communication technology. Where resource-limited health systems face challenges caused by the increasing burden of chronic diseases and an aging global population, telehealth has been advocated as a solution for changing and improving the paradigm of healthcare delivery to cope with these issues. The aim of this systematic review is to investigate the effect of telehealth interventions on two indicators: hospitalization rate and length of stay.

Materials and Methods: The reviewers searched the PubMed, ScienceDirect, and Springer electronic databases from January 2005 to November 2013. A search strategy was developed using a combination of the following search keywords: impact, effect, telehealth, telemedicine, telecare, hospitalization, length of stay, and resource utilization. Both randomized controlled trials and observational studies were included in the review. To be included in the review, articles had to be written in English. The results of study were compiled, reviewed, and analyzed on the basis of the review aims.

Results: This systematic review examined 22 existing studies with a total population of 19,086 patients. The effect of telehealth on all-cause hospitalization was statistically significant in 40 percent of the related studies, whereas it was not statistically significant in 60 percent. Similarly, the effect of telehealth on the all-cause length of stay was statistically significant in 36 percent of the studies and nonsignificant in 64 percent.

Conclusion: Considering the fact that hospitalization rate and length of stay can be confounded by factors other than telehealth intervention, studies examining the effect of the intervention on these indicators must take into account all other factors influencing them. Otherwise any judgment on the effect of telehealth on these indicators cannot be valid.

Keywords: telehealth, telemedicine, impact, length of stay, hospital admission

Introduction

Telehealth has been defined as the remote delivery of healthcare services using information and communication technology.\(^1\) The term is broader than telemedicine and covers a variety of physician and nonphysician services.\(^2\) The wide availability of the Internet accompanied by the increasing pace of technological advances has provided new opportunities for telehealth.\(^3\)
Where resource limited-health systems face challenges caused by an increasing burden of chronic diseases and the aging global population, telehealth has been advocated as a solution for changing and improving the current paradigm of healthcare delivery to cope with these issues. However, its opponents continue to criticize it.

Several systematic reviews have investigated the effects of various telehealth interventions on aspects of healthcare and healthcare delivery, and they have infrequently found consistent results of those interventions. Few systematic reviews of the effects of telehealth interventions on hospital indicators have been conducted. These reviews have been restricted to populations of patients with particular types of diseases, or they have investigated particular effects of telehealth, for instance the socioeconomic effect, and have reported that the positive effects of telehealth on those aspects could not be generalized beyond those particular studies. To the best of our knowledge, no systematic review has been conducted to explore the effect of telehealth interventions on hospital indicators among different types of patients regardless of disease type.

In this analysis, studies of the effect of telehealth interventions on two main hospital indicators were reviewed. The outcome of the studies reviewed could be positive, negative, or neutral. Therefore, conflicting results are to be expected. This article presents the reported evidence on the effect of telehealth and the characteristics of those reports. The intention of this article is not to assess or pass judgment on the value of telehealth.

Methodology

Criteria for Considering Studies for the Review

Both randomized controlled trials and observational studies were included in the review. Systematic reviews or other types of studies were excluded. All forms of telehealth interventions ranging from telephone to two-way videoconferencing (either asynchronous or real-time technologies) were included in this review. In the studies, patients receiving any type of telehealth interventions were compared with those receiving usual face-to-face care. No limitation was set for the participants or the country of the study.

Studies were included if they reported objective measures of hospitalization or length of stay. Studies in which outcomes were related to any institution other than hospital, such as home care facilities or correctional facilities, were excluded from this review. Papers had to be written in English to be included. Articles with any bias toward possible influencing effects on the outcomes were also excluded. For instance, if the severity of disease differed between the intervention group and the control group in a study, the study was excluded. Figure 1 illustrates the process of selecting studies for the detailed review.

Search Methods for Identification of Studies

The reviewers searched the PubMed, ScienceDirect, and Springer electronic databases for articles published from January 2005 to November 2013. A search strategy was developed using a combination of the following keywords: impact, effect, telehealth, telemedicine, telecare, hospitalization, length of stay, and resource utilization.

Data Extraction

Eligible papers were reviewed independently by the reviewers using a data extraction form that was developed for the purpose of this review and contained the following data elements:

- Name of the author
- Year of publication
- Size of population in both the intervention and control groups
- The country in which the study took place
- Title of the study
- Design type of the study
• Devices used for the telehealth intervention
• The specified aim of the telehealth intervention
• The type of intervention (i.e., real-time vs. asynchronous)
• Participants’ type of illness
• Indicators on hospitalization rate or length of stay
• The statistical significance of the effect of the telehealth intervention on each of the indicators

In the process of the review and the data extraction, any disagreement among the investigators was resolved utilizing team discussion to achieve consensus.

Assessing Risk of Bias

The quality of studies was assessed using a mixed-method assessment tool. Depending on the study design, a range of criteria were used to assess the risk of bias. Criteria considered for assessing the studies included the following:

• A clear description of randomization
• Allocation concealment or blinding
• Completeness of outcome data
• Quality of outcome reporting
• Sampling and sample justification
• Control of confounding factors

Results

Basic Characteristics of the Studies

A summary of the basic characteristics of all 22 studies included in the review is provided in Table 1. As can be seen, 14 of the 22 studies were randomized controlled trials, and 8 studies used an observational method design. The age of the population in all studies ranged from 55 to 77 years except for one that was conducted on a population of infants. The purpose of the telehealth interventions in the studies included the following:

• Monitoring
• Education
• Supporting
• Measuring
• Managing
• Consultation

Table 2 illustrates the different devices that were employed to perform the interventions. These include:

• Telephones
• Mobile phones
• Television sets (used as monitors)
• Computerized Internet-based devices
• Automated self-monitoring devices
• Telemeasuring devices
• Video cameras
• Personal digital assistants
• Wireless Bluetooth devices
In the randomized controlled trials, the follow-up duration for measuring the outcomes ranged from 2 to 26 months, whereas in the observational studies the follow-up duration ranged from 6 to 48 months.

**Effect of Telehealth on Hospitalization and Length of Stay**

The effect of telehealth on hospitalization and length of stay was categorized on the basis of the reason for admission including all-cause, heart failure, other cardiac conditions, and other noncardiac reasons (see Table 2).22–43

The effect of telehealth on all-cause hospitalization was statistically significant (significant decrease) in 40 percent of the studies that reported hospitalization outcomes, whereas it was not statistically significant in 60 percent of those studies. Similarly, the effect of telehealth on all-cause length of stay was statistically significant (significant decrease) in 36 percent of the studies that reported a length-of-stay outcome, and it was not significant in 64 percent of those studies.

**Discussion**

This systematic review included 22 existing studies with a total population of 19,086 patients. The basic characteristics of the studies are discussed first, and then more detail regarding the effects of telehealth on hospitalization rate and length of stay is provided.

*Age and Diseases in the Population*

Although telehealth can be utilized to provide services for different age groups,44 the average age of the population in the included studies was found to be high (i.e., older) in this review. This finding can be attributed to the fact that most previous studies had been conducted on participants with chronic conditions, and about 75 percent of the elderly have at least one chronic disease and 50 percent have at least two chronic conditions.45 The total population in the studies had chronic conditions, which may be a consequence of the realization that patients with chronic conditions impose heavy financial pressures on healthcare systems46 and that these conditions can be managed less expensively and more effectively by using telehealth interventions. The cost savings and increased effectiveness therefore justify the focus of telehealth programs on chronic conditions.47

Moreover, a growing body of evidence supports the use of telehealth as an effective solution for the management and care of chronic conditions.48 The chronic diseases for which telehealth intervention was applied in the studies are diabetes, heart failure, coronary heart disease, chronic obstructive pulmonary diseases, and congenital heart disease, and one study examined social care needs; this range of conditions is similar to the spectrum of diseases found in a study conducted on UK telehealth systems.49

**Type of the Studies**

More observational studies reported significant effects than randomized controlled trials did. This finding is consistent with those of the systematic review conducted by Louis et al.50 and the results reported by Chaudhry et al., 51 in which no significant effect was found in randomized controlled trial studies in contrast with observational studies. Other reports support this finding.52, 53

*Devices Used for the Telehealth Intervention*

Different devices from various vendors were used for the telehealth interventions in the included studies. This pattern was consistent with the equipment listed in a study describing the model of information exchange in UK telehealth systems.54 The devices with the highest range of usage were telemonitoring tools; this basic required measurement and communication equipment was ubiquitous. This finding is in accordance with the results of a systematic review emphasizing telemonitoring as a promising patient management mechanism in chronic diseases.55 Telemonitoring has also been referred to as one of the common applications of information technology in the management of chronic diseases56 and as a facilitating technology in care management of chronic conditions.57 The telephone was the device with the second highest usage in the studies. This device was used not only for direct communication
between healthcare providers and patients but also as a key component of telemonitoring equipment for transferring remote monitoring data. The prevalent usage of the telephone could be due to its wide availability, high level of acceptability to the majority of the population, and ease of use.

**Type of Telehealth Modality**

The modality of the technology used for interventions was asynchronous in most of the studies, as was the case in a systematic review conducted on teleconsultations for diabetes care. This finding may be due to the fact that implementation of real-time telehealth interventions can be much more expensive than implementation of asynchronous ones. However, different results have been reported regarding the outcomes of interventions using these two modalities. Although one study reported low clinical efficacy of the asynchronous modality compared to real-time interventions, other studies documented no difference in the outcomes of these two modalities.

Studies of interventions using a hybrid modality (both real-time and asynchronous) were a minority among the included studies. No considerable difference could be observed between the real-time and asynchronous modality interventions in terms of their effects on the hospital indicators that are the subject of this review. The same trend was reported in the systematic review conducted on teleconsultation for diabetes care.

**Country and Place of the Intervention**

Not a single study included in this review originated in developing countries. This finding is similar to the results of a systematic review on the use of telehealth in Asian countries, in which no study was found to have been conducted on telehealth interventions in Asia. Most of the studies in this review originated in the United States. This finding is in line with existing evidence reported on telehealth trends and can be attributed to the substantial investment made by the US federal government in telemedicine networks, technologies, and research. In addition, no study was found to have been conducted on rural populations or in medically underserved communities despite the fact that telehealth intervention can provide opportunities to increase individuals’ contact with healthcare services in those types of areas and communities.

**Effect of the Intervention on the Hospital Indicators**

This systematic review reveals conflicting effects of the telehealth interventions on hospitalization rates in different studies. About 60 percent of the interventions reported no significant effect on the hospitalization rate, and a significant decrease was observed in only 40 percent of the interventions. Although these findings are consistent with the findings of different reviews reporting the weak effect of telehealth on some aspects of healthcare and healthcare delivery, they are contrary to other evidence reporting the positive effect of telehealth in different domains of healthcare.

In terms of the effect of telehealth on length of stay, no significant effect was reported in 64 percent of the studies, and a significant decrease was observed in 36 percent of the studies.

In this review, the telehealth interventions aimed at the education of patients were found to significantly decrease both the hospitalization rate and the length of stay, and existing evidence supports this result. A study of the effect of electronic education on metabolic control indicators of diabetes confirms the positive effect of tele-education, which can be considered to have a transforming effect on patients’ behavior and thereby lead to better self-care management. In fact, patient education is a key element of self-management in chronic disease because it enhances patients’ ability to manage their own diseases, and it has been discussed in literature as a critical factor for realizing patient-centered care. Of course, healthcare professionals’ own attitudes toward the benefit of telehealth is an important factor that influences the ultimate effectiveness of patient education and must not be ignored.

The mixed outcomes observed in the studies can be attributed to the fact that an independent initiative rather than an integrated telehealth approach was used in each of the studies, and considerable differences exist among telehealth programs and devices in terms of their quality, reliability, and interoperability. This variability may influence the intervention outcome, as has been highlighted in the literature. In addition, no standard guideline or integrated framework has been established for implementation and
evaluation of telehealth programs, making their outcomes more difficult to compare. Moreover, the duration of the intervention and its effect on patients’ familiarity with the technology may also influence the outcome of telehealth interventions.

### Possible Effects of Factors Other Than Telehealth

Differences observed in outcomes of telehealth interventions might be a consequence of various factors on which no information was provided in the included studies. Among these factors are the contextual conditions of a telehealth implementation that can influence the outcome. It is important to bear in mind that neither technology nor patients act identically in all situations and contexts.

Outcomes may also vary with the socioeconomic status of patients. In some reports, longer length of stay has been attributed to the lack of family support and a significant distance between the hospital and the patient’s home. Individual patients’ social problems have also been identified as predictors of hospitalization, but despite such evidence, this factor has been ignored in most of the existing telehealth studies.

Differences observed in the effects of telehealth can also be the result of differences in a patient’s personal perception of the intervention; this perception affects the acceptability of the intervention, and as a result, patients may be more inclined to use one particular type of telehealth intervention rather than other available types. More importantly, the quality of the partnership between patients and care providers can also play a significant role in optimizing the potential of telehealth.

Variation in the severity of illness on admission, the day of admission, and patient comorbidities have also been reported to be important factors influencing length of stay. These same factors can influence patient discharge status, the quality of care in a previous hospital stay can influence the likelihood of future patient hospitalization, and the existing hospital bed occupancy rate can also have an effect on length of stay.

### Conclusion

Investigation of the effect of telehealth interventions should not be conducted in a vacuum. Considering the fact that hospitalization and length of stay can be confounded by factors other than telehealth intervention, any study examining the effect of telehealth interventions on these two indicators must be designed to take into account other factors that influence their effectiveness; otherwise, any judgment on the effect of telehealth based on these indicators will not be valid. The conflicting effects observed in telehealth studies could arise from factors other than the intervention itself.

### Acknowledgments

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Mohsen Hosseini is MSc student in health information technology at the School of Management and Medical Informatics at Tabriz University of Medical Sciences in Tabriz, Iran.
Notes


66. Domingo, M., J. Lupon, et al. “Noninvasive Remote Telemonitoring for Ambulatory Patients with Heart Failure: Effect on Number of Hospitalizations, Days in Hospital, and Quality of Life. CARME (CAtalan Remote Management Evaluation) Study.”
67. Schofield, R., S. Kline, et al. “Early Outcomes of a Care Coordination-enhanced Telehome Care Program for Elderly Veterans with Chronic Heart Failure.”
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118. Whellan, D., X. Zhao, et al. “Predictors of Hospital Length of Stay in Heart Failure: Findings from Get with the Guidelines.”
Figure 1

Flowchart Representing the Selection of Studies for the Systematic Review of the Effects of Telehealth on Hospitalization Indicators

Articles were initially identified from PubMed, ScienceDirect, and Springer databases \( n = 804 \)

Articles were excluded because of irrelevant titles \( n = 3015 \)

153 articles were identified as relevant on the basis of their titles

Articles were found from PubMed citations \( n = 2364 \)

76 duplicates were removed

77 abstracts were identified and screened

33 abstracts were excluded

44 full-text articles were assessed

22 articles were excluded for the following reasons:
- Irrelevant outcomes and intervention \( n = 9 \)
- Biases in intervention and control groups \( n = 9 \)
- Inappropriate design \( n = 3 \)
- Duplicate reporting of same results in two different publications \( n = 1 \)

22 studies were included in the final list for the review
### Table 1

Characteristics of Studies Included in the Systematic Review Examining the Effects of Telehealth on Hospitalization Indicators

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Country</th>
<th>Type of Study</th>
<th>Mean Participant Age in Years</th>
<th>Type of Disease</th>
<th>Purpose of Intervention</th>
<th>Type of Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wakefield et al.(^a)</td>
<td>United States</td>
<td>RCT</td>
<td>69</td>
<td>HF</td>
<td>To support patients after discharge</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Morguet et al.(^b)</td>
<td>Germany</td>
<td>Obs</td>
<td>61</td>
<td>HF</td>
<td>To educate and monitor patients’ body weight, blood pressure, and pulse rate daily</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Scherr et al.(^c)</td>
<td>Austria</td>
<td>RCT</td>
<td>66</td>
<td>HF</td>
<td>To measure patients’ vital parameters (blood pressure, heart rate, body weight) and send them to the monitoring center</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Dinesen et al.(^d)</td>
<td>Denmark</td>
<td>RCT</td>
<td>68</td>
<td>COPD</td>
<td>To assess the patient’s data, monitor the patient’s disease, and provide advice to the patient</td>
<td>H</td>
</tr>
<tr>
<td>Bowles et al.(^e)</td>
<td>United States</td>
<td>RCT</td>
<td>75</td>
<td>DB, HF</td>
<td>To support patient care; to monitor and instruct patients on self-care and disease management</td>
<td>H</td>
</tr>
<tr>
<td>Steventon et al.(^f)</td>
<td>England</td>
<td>Obs</td>
<td>66</td>
<td>CHD, DB, HF, COPD</td>
<td>To ask patients about current health status and encourage patients to better manage their health conditions</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Dang et al.(^g)</td>
<td>United States</td>
<td>Obs</td>
<td>72</td>
<td>DB, HF, COPD</td>
<td>To monitor and exchange disease-related information between patients and caregivers</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Steventon et al.(^h)</td>
<td>England</td>
<td>RCT</td>
<td>70</td>
<td>DB, HF, COPD</td>
<td>To monitor and educate patients</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Soran et al.(^i)</td>
<td>United States</td>
<td>RCT</td>
<td>76</td>
<td>HF</td>
<td>To monitor and detect early signs and symptoms of heart failure</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Ferrante et al.(^j)</td>
<td>Argentina</td>
<td>RCT</td>
<td>65</td>
<td>HF</td>
<td>To improve patients’ diet and treatment, promote exercise, and regularly monitor symptoms, weight, and edema</td>
<td>H</td>
</tr>
<tr>
<td>Jia et al.</td>
<td>United States</td>
<td>Obs</td>
<td>68</td>
<td>DB</td>
<td>To answer questions about patients’ symptoms and monitor daily information</td>
<td>H</td>
</tr>
<tr>
<td>Chen et al.</td>
<td>Taiwan</td>
<td>Obs</td>
<td>63</td>
<td>HF</td>
<td>To educate and communicate (two-way) with patients on diet therapy, fluid restriction, and adverse drug effects</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Weintraub et al.</td>
<td>United States</td>
<td>RCT</td>
<td>69</td>
<td>HF</td>
<td>To assess variables important to patient care management</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Steventon et al.</td>
<td>England</td>
<td>RCT</td>
<td>75</td>
<td>SCN</td>
<td>To monitor functions, security and environments of patients</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Giordano et al.</td>
<td>Italy</td>
<td>RCT</td>
<td>57</td>
<td>HF</td>
<td>To telemonitor and tele-assist</td>
<td>H</td>
</tr>
<tr>
<td>Webb et al.</td>
<td>United States</td>
<td>Obs</td>
<td>0.67</td>
<td>CoHD</td>
<td>To send echocardiography studies from the community hospital to the tertiary hospital to be interpreted</td>
<td>LOS</td>
</tr>
<tr>
<td>Dendale et al.</td>
<td>Belgium</td>
<td>RCT</td>
<td>76</td>
<td>HF</td>
<td>To measure body weight, blood pressure, and heart rate and send them to the central computer</td>
<td>H</td>
</tr>
<tr>
<td>Domingo et al.</td>
<td>Spain</td>
<td>Obs</td>
<td>66</td>
<td>HF</td>
<td>To record weight, heart rate, and blood pressure and send them to the healthcare staff supporting patients via a dedicated web application</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Schofield et al.</td>
<td>United States</td>
<td>Obs</td>
<td>67</td>
<td>HF</td>
<td>To report and update patient symptoms and vital signs</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Koehler et al.</td>
<td>Germany</td>
<td>RCT</td>
<td>67</td>
<td>HF</td>
<td>To do daily self-assessment of blood pressure, body weight, and electrocardiography and send the results to the central server</td>
<td>H, LOS</td>
</tr>
<tr>
<td>Cleland et al.</td>
<td>Holland Germany United Kingdom</td>
<td>RCT</td>
<td>67</td>
<td>HF</td>
<td>To assess patients’ symptoms and medication; to measure weight, blood pressure, heart rate, and heart rhythm and communicate the information</td>
<td>LOS</td>
</tr>
</tbody>
</table>
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Dansky et al. United States RCT 77 HF To take measurements of blood pressure, pulse, weight; to allow two-way, synchronous interaction between nurse and patient

Abbreviations: DB, diabetes; CHD, coronary heart disease; CoHD, congenital heart disease; COPD, chronic obstructive pulmonary disease; H, hospitalization; HF, heart failure; LOS, length of stay; Obs, observational; RCT, randomized controlled trial; SCN, social care needs.

Note: All studies in this table had usual care as the control.

j Ferrante, D., S. Varini, et al. “Long-Term Results after a Telephone Intervention in Chronic Heart Failure: DIAL (Randomized Trial of Phone Intervention in Chronic Heart Failure) Follow-up.” *Journal of the American College of Cardiology* 56, no. 5 (2010): 372–78.


Table 2

Summarization of the Effects of Telehealth on Hospitalization Indicators in Studies Included in the Systematic Review

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Intervention Device (Modality)</th>
<th>Sample Size</th>
<th>Follow-up in Months</th>
<th>Statistically Significant Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wakefield et al.</td>
<td>1. Telephone (R) 2. Patient station consisting of television monitor and video camera kit with a microphone (R) 3. Combined tools (R) Intervention 1: 47 Intervention 2: 52 Intervention 3: 99 Control: 49</td>
<td></td>
<td>12</td>
<td>Intervention 3: all-cause, SD None</td>
</tr>
<tr>
<td>Morguet et al.</td>
<td>Telephone and the telemonitoring equipment (R) Intervention: 32 Control: 96</td>
<td></td>
<td>11</td>
<td>All-cause, SD Other noncardiac reasons, SD All-cause, SD Other cardiac reasons, SD</td>
</tr>
<tr>
<td>Scherr et al.</td>
<td>Weight scale, sphygmomanometer, mobile phone, and client-server communication through Internet (A) Intervention: 54 Control: 54</td>
<td></td>
<td>6</td>
<td>None Heart failure, SD</td>
</tr>
<tr>
<td>Dinesen et al.</td>
<td>Telehealth monitor system using wireless technology (A, R) Intervention: 57 Control: 48</td>
<td></td>
<td>10</td>
<td>All-cause, SD None</td>
</tr>
<tr>
<td>Bowles et al.</td>
<td>1. Telephone (R) 2. Physiological monitor equipped with a blood pressure cuff, body weight scale, glucometer, pulse oximeter, digital stethoscope, and videoconferencing devices (R) Intervention 1: 93 Intervention 2: 98 Control: 112</td>
<td></td>
<td>2</td>
<td>None None</td>
</tr>
<tr>
<td>Steventon et al.</td>
<td>Telephone (R) Intervention: 2,698 Control: 2,698</td>
<td></td>
<td>12</td>
<td>None None</td>
</tr>
<tr>
<td>Dang et al.</td>
<td>Computerized, Internet-based, and in-home messaging and monitoring device for automating the daily monitoring of the enrolled patients by a care coordinator (A) Congestive heart failure 17, control 17 Chronic obstructive pulmonary disease 17, control 17 Diabetes mellitus 23, control 23</td>
<td></td>
<td></td>
<td>Heart failure, SD None None None</td>
</tr>
<tr>
<td>Steventon et al.</td>
<td>Remote, automatic, and passive monitoring system in Intervention: 1,570 Control: 1,584</td>
<td></td>
<td>12</td>
<td>All-cause, SD All-cause, SD</td>
</tr>
<tr>
<td>Study</td>
<td>Intervention Details</td>
<td>Treatment Group</td>
<td>Control Group</td>
<td>Outcome Measures</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Soran et al. [1]</td>
<td>Electronic scale and an individualized symptom response system linked via standard phone line to a computerized database (A)</td>
<td>Intervention: 160 Control: 155</td>
<td>6 None</td>
<td>None</td>
</tr>
<tr>
<td>Ferrante et al. [1]</td>
<td>Telephone (R)</td>
<td>Intervention: 760 Control: 758</td>
<td>12–48 Heart failure, SD</td>
<td>None</td>
</tr>
<tr>
<td>Jia et al. [2]</td>
<td>Home telehealth device (messaging device) and telephone (R)</td>
<td>Intervention: 387 Control: 387</td>
<td>48 None</td>
<td>None</td>
</tr>
<tr>
<td>Chen et al. [1]</td>
<td>Telephone (R)</td>
<td>Intervention: 275 Control: 275</td>
<td>6 All-cause, SD Heart failure, SD</td>
<td>All-cause, SD Heart failure, SD</td>
</tr>
<tr>
<td>Weintraub et al. [3]</td>
<td>Tele-measurement devices and an interactive communication device (A)</td>
<td>Intervention: 95 Control: 93</td>
<td>3 None</td>
<td>None</td>
</tr>
<tr>
<td>Steventon et al. [4]</td>
<td>Tele-care base unit along with a pendant alarm and up to 27 various peripheral devices (R)</td>
<td>Intervention: 1,236 Control: 1,190</td>
<td>12 None</td>
<td>None</td>
</tr>
<tr>
<td>Giordano et al. [5]</td>
<td>Portable measurement devices transferring data by a fixed or mobile telephone; one lead trace to a receiving station where health professional was available (A)</td>
<td>Intervention: 226 Control: 229</td>
<td>12 All-cause, SD Heart failure, SD</td>
<td>None</td>
</tr>
<tr>
<td>Webb et al. [6]</td>
<td>Interactive system along with store and forward system (A)</td>
<td>Intervention: 337 Control: 337</td>
<td>36 None</td>
<td>All-cause, SD</td>
</tr>
<tr>
<td>Dendale et al. [7]</td>
<td>Electronic weight scale, a blood pressure monitoring device along with a cell-phone, central computer (A)</td>
<td>Intervention: 80 Control: 80</td>
<td>6 None</td>
<td>None</td>
</tr>
<tr>
<td>Domingo et al. [8]</td>
<td>Interactive platform, automated self-monitoring equipment, Internet connection, and television used as monitor (A)</td>
<td>Intervention: 92 Control: 92</td>
<td>12 Heart failure, SD Other cardiac reasons, SD</td>
<td>Heart failure, SD Other cardiac reasons, SD</td>
</tr>
<tr>
<td>Schofield et al. [9]</td>
<td>In-home messaging device, a secure</td>
<td>Intervention: 73 Control: 73</td>
<td>6 All-cause, SD</td>
<td>All-cause, SD</td>
</tr>
<tr>
<td>Study</td>
<td>Description</td>
<td>Intervention</td>
<td>n</td>
<td>Control</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>Koehler et al.</td>
<td>Internet site, and telephone (A)</td>
<td>Intervention: 354 Control: 356</td>
<td>26</td>
<td>None</td>
</tr>
<tr>
<td>Cleland et al.</td>
<td>Portable measuring devices connected to a personal digital assistant for transferring information via cell phone to telemedicine centers (A)</td>
<td>Intervention 1: 170 Intervention 2: 163 Control: 85</td>
<td>8</td>
<td>None</td>
</tr>
<tr>
<td>Dansky et al.</td>
<td>Tele-home-care system: telephone-based communication system with medical peripherals (A, R)</td>
<td>Intervention: 174 Control: 112</td>
<td>2, 4</td>
<td>At 2 months: SD (not significant at 4 months)</td>
</tr>
</tbody>
</table>

**Abbreviations**: A, asynchronous; R, real-time; SD, significant decrease.

Ferrante, D., S. Varini, et al. “Long-Term Results after a Telephone Intervention in Chronic Heart Failure: DIAL (Randomized Trial of Phone Intervention in Chronic Heart Failure) Follow-up.” *Journal of the American College of Cardiology* 56, no. 5 (2010): 372–78.


