

## A Meta-Analysis to Determine Enhancement of Adherence to Telemonitoring by Congestive Heart Failure Patients

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### Abstract

**Background:** Chronic heart failure (CHF) is one of the most life-threatening conditions. Patient populations living with the disease experience high rates of mortality and cardiac morbidities. Research examining the compliance of CHF patients to telemonitoring programs such as cardiac rehabilitation programs, reveals that patients, especially of older ages, tend to show less compliance and more drop out of these programs.

**Methods:** The researcher used 8 out of 16 randomized controlled trials identified from the following databases until April 2019: The Cochrane Library, CINAHL, and Medline. The researcher used various randomized controlled trials identified from the following databases until April 2019: The Cochrane Library, CINAHL, and Medline. The meta-analysis will investigate the various ways to upgrade the compliance of CHF patients. The RCTs from the identified studies were then fully reviewed and included in the meta-analysis if they satisfied the criteria below had prospectively enrolled patients with confirmed congestive heart failure, reviewed patient randomized to access telemonitoring programs, and discusses more than one of the primary and secondary outcomes. To assess the progress of compliance, the patients can be monitored for various factors including self-reporting of daily measurements of healthcare parameters, use of healthcare resources and the actual usage of the technology used in telemonitoring.

**Limitations:** The reviewed evidence mainly focuses on the compliance of heart failure patients and does not assess the process of telemonitoring.

**Conclusion:** Currently more innovative technology, other than telephone calls and the use of mobile phone applications is being investigated for possible future use. Accordingly, the use of artificial intelligence is being investigated to support clinical decision making and imaging interpretations by the patient. Socio-economic factors, patient related factors such as age and were also reported to implicate compliance. Accordingly, elderly was more likely to suffer cognition and physical impairments implicating their ability to effectively understand and interpret the processes involved in the telemonitoring program.

**Keywords:** Meta-analysis; Tele-monitoring; Congestive heart failure

### Introduction

Chronic heart failure (CHF) is one of the most life-threatening conditions. It is majorly characterized by occasional exacerbations and recurrent hospitalization of the patients. Patient populations living with the disease experience high rates of mortality and cardiac morbidities [1,2]. Due to the risks involved in the management of the condition, compliance with the outlaid evidence-based guidelines is essential for the survival and quality of life of the patients. Regardless, studies have indicated that compliance among the patients remains very low and practically difficult [3]. Research has established a reduction in the supply of adequate care for CHF patients due to the limited supply of both human and working resources in the healthcare systems. As a result, there is a need to enhance the compliance of patients to alternative methods of monitoring the condition through telemedicine.

Previous research examining the compliance of CHF patients to telemonitoring programs such as cardiac rehabilitation programs,

reveals that patients, especially of older ages, tend to show less compliance and more drop out from these programs. The studies indicate that while adherence to telemonitoring requires a great investment in terms of telemonitoring education of the patients and the implementation of the automated telemonitoring tool, it is worth as it will consequently help in monitoring and preventing the risks associated with CHF. It is therefore imperative that the CHF's patient's compliance to telemonitoring is enhanced through considering the various factors that are implicated in the process and those that can be used to improve it.

Research regarding general patient compliance to telemonitoring has shown that various factors are involved in the process. In a study investigating the contribution of various factors to the patient adherence to telemonitoring in management of factors contributing to CHF, Kerby (2013) determined that the adherence among older adults with a college education, males and white non-Hispanic ethnic groups had higher adherence than other corresponding categories. The study, therefore, indicates that factors such as CHF patient education, sex, and age determined their likelihood to adhere to the telemonitoring programs. In assessing whether adherence alone could prevent

hospitalizations, Gallagher [4] found out that among a patient population of 40, there were no significant differences in the rates of hospitalizations between the intervention and passive monitoring populations. This outcome could either mean that other factors affect the outcome of compliance or there is needed to further establish whether telemonitoring adherence could be suitable in the reduction of hospitalizations.

This meta-analysis aims at determining the enhancement of congestive heart failure patients' compliance with the telemonitoring in the management of the condition. The meta-analysis is based on previous randomized controlled trials that have shown the significance of factors such as age, education, and sex on the compliance of the target population to assigned telemonitoring programs. In consideration of these factors, the meta-analysis will explore the various ways to enhance the compliance of CHF patients. Interventions include the education and training of patients and the implementation of automatic feedback systems.

## Materials and Methods

### Data sources and searches

The researcher used various randomized controlled trials identified from the following databases until April 2019: The Cochrane Library, CINAHL, and Medline. The search language was restricted to RCTs published in the English language only. Further, the search for RCTs used in the meta-analysis was restricted to studies published within the last five years. Related RCTs found in the reference of the studies were searched and included as well.

### Search term and strategies

Patient compliance, Patient adherence, Telemedicine, Adherence factors, Telemonitoring education, Indicators of compliance, Chronic heart failure patients.

### Study selection

The selection of studies was conducted by two independent reviewers. The reviewers examined all the abstracts and the studies were included if they considered the enhancement of congestive heart failure patients' compliance with telemonitoring. The RCTs from the identified studies were then fully reviewed and included in the meta-analysis if they satisfied the criteria below:

Had prospectively enrolled patients with confirmed congestive heart failure.

Reviewed patient randomized to access telemonitoring programs.

Discusses more than one of the primary and secondary outcomes

In-patients and those who resided within nursing facilities or received home care visits were excluded from the study. Further, patients who denied informed consent were excluded from the study.

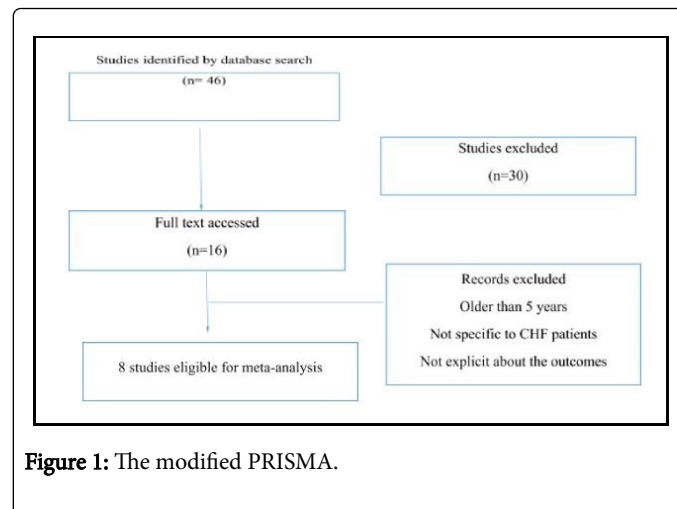
### Extraction of data and assessment of quality

The reviewers independently determined the eligibility of the studies identified in the search for inclusion. Studies considered eligible based on a standardized data abstraction form was subject to the extraction of data. Based on relevant tools the methodological

quality of the studies was assessed and the general quality of the RCTs determined.

## Results

Of the 46 studies identified through the literature search, 30 were excluded after examining their respective titles and abstracts. After assessing the full manuscript of the remaining 16 studies, the research identified 8 to be eligible for the meta-analysis. The modified PRISMA is indicated in the below Figure 1 and Table 1 [5-16].



**Figure 1:** The modified PRISMA.

Author/Year/Reference	Study Population	Interventions	Follow-up lengths
Ong et al. (2016) [11]	Chronic heart failure patients; 50+ years old; median age 73 years; 45.45 percent female; 22.1 African-American.	Combination of telemonitoring and health coaching telephone calls.	180 days
Gallagher et al. (2017) [4]	Discharged patients with heart failure; Median age 64 years; 25% female; 45% female; 45% Hispanic;	Telemonitoring with smart phones support	10 months
Prescher et al. (2014)	Chronic heart failure patients NYHA class II/III.	Telemonitoring for adherence to HF management parameters	-
Boyne et al. (2014) [1]	Heart failure patients; mean age 72 years; 59% male; 65% living with partners.	Telemonitoring and education on telemonitoring by healthcare professionals	1 year
Vuorinen et al. (2014) [19]	Heart failure patients	Home telemonitoring	-
Piotrowicz et al. (2015) [13]	Heart failure patients	Home-based telemonitoring	-

Ding et al. (2017) [6]	Chronic heart failure patients	Innovative telemonitoring enhanced care and structured telephone support.	6 months
Scalvini (2016) [16]	Chronic heart failure patients	Phone contact and telemonitoring of cardiac parameters	4-6 months

**Table 1:** The characteristics of the studies as based on the AMSTAR quality assessment are indicated in the table.

**Direct comparisons**

The direct comparison reveals that telemonitoring with telephone calls (0.91 [0.51, 1.51]) was used in four of the studies (Ding; Gallagher; Ong; Scalvini) [3,4,11,16]. Other methods of intervention used to ensure compliance included innovative telemonitoring, health coaching (0.991 [0.55, 1.57]), and patient education (0.71 [0.32, 1.67]).

Combination of telemonitoring and health coaching telephone calls	Telemonitoring with telephonic support	Telemonitoring for adherence to HF management parameters	Telemonitoring education telemonitoring healthcare professionals and on by	Home telemonitoring	Homed-based telemonitoring	Innovative telemonitoring enhanced care and structure telephone support.	Phone contact and telemonitoring of cardiac parameters
0.99 (0.56,1.67)	0.66 (0.23, 1.03)	1.49 (0.54, 2.87)	1 (0.68, 2.61)	1.27 (0.83, 2.51)	1.29 (0.98, 3.14)	0.48 (0.24, 1.35)	1.19 (0.95, 2.67)
1.97 (0.89, 1.71)	0.56 (0.61, 1.22)	1.21 (0.61, 2.58)	1.39 (0.94, 2.61)	1.26 (1.03, 3.07)	0.57 (0.27, 1.49)	1.29 (0.9981, 3.12)	1.09 (0.71, 2.22)
1.62 (0.46, 1.14)	0.63 (0.46, 0.85)	1.31 (0.81, 2.44)	0.91 (0.51, 1.51)	0.78 (0.36, 1.16)	1.32 (1.01, 3.23)	NA	1.19 (0.83, 2.13)
0.97 (0.63, 0.91)	1.23 (0.62, 2.33)	1.17 (0.44, 2.71)	0.89 (0.57, 1.99)	0.991 (0.55, 1.57)	1.03 (0.66, 2.01)	NA	0.71 (0.32, 1.67)
1.18 (0.55, 2.22)	1.13 (0.77, 2.14)	0.97 (0.61, 1.49)	1.15 (0.39, 2.59)	0.79 (0.31, 1.09)	1.15 (0.71, 2.03)	NA	1.02 (0.33, 0.65)
1.36 (0.49, 2.99)	1.07 (0.87, 1.77)	1.09 (0.71, 2.04)	0.97 (0.29, 1.23)	0.88 (0.42, 1.44)	1.29 (1.04, 2.86)	NA	1.12 (0.49, 1.70)
1.2 (0.90, 2.48)	1.34 (0.46, 2.97)	1.21 (0.98, 2.66)	1.01 (0.45, 2.13)	1.31 (0.56, 2.78)	NA	NA	1.34 (1.02, 2.88)
NA	NA	NA	NA	NA	NA	NA	NA

**Table 2:** Interventions used in the studies.

**Heart failure hospitalizations**

Through the integration of indirect evidence, it was noted that use of innovative technology (0.991 [0.55, 1.57]), patient education (0.71 [0.32, 1.67]), and telemonitoring with telephone calls (0.91 [0.51, 1.51]) all had significant contributions in enhancing the compliance of the heart failure patients. As a result, these approaches led to the reduction of hospitalizations for the heart failure patients. The use of more patient education with the use innovative technologies in telemonitoring was the best in enhancing compliance among the heart failure patients. Integration of phone calls was also considered important in monitoring patient progress but less effective in

The investigated studies revealed that home-based telemonitoring through the support of family was also effective in ensuring compliance (0.97 [0.63, 0.91]). One study by Prescher et al. [14] discussed the various factors and parameters that may influence compliance to telemonitoring by the patients. Moreover, the meta-analysis compared between the significance of the impact of the socioeconomic factors and the interventional methods on the compliance of the heart failure patients to the telemonitoring process.

**Adherence indicators**

To determine the effectiveness of adherence, the following indicators were examined including the remote patient management through reporting daily measurements of ECG, blood pressure, and weight, the HF compliance questionnaire scores, the proportion of weekly submitted self-measurements, and increased use of healthcare resources. The factors affecting adherence were also monitored including socio-demographic factors- education, knowledge (user experience), and age and disease-related factors- patient’s healthcare status (Table 2).

determining structured patient data, including the transmission of electrocardiograph data [17-20].

**Heart failure-related mortality**

However, use of innovative technology enabling the effective transmission of electrocardiograph data, and monitoring was associated with reduced death probabilities. Patients undertaking regular and structured phone contacts with the healthcare providers had more compliance compared to those who did not. As a result, they had lower chances of mortality compared to individuals who used other methods with lower compliance or followed usual care.

Generally, factors that enhanced regular contact and monitoring of heart failure patients use of the telemonitoring methods enhanced their compliance and adherence to the assigned medical regimen and self-care practices. These factors included the level of education of the patients, their knowledges and training on the telemonitoring approach and its importance. Other factors included the age of the patients and the availability of care-giver or family support. As a result of enhanced compliance of the patients, there resulted an increased quality of life and reduced chances of mortality for these heart failure patients. Regardless of the aforementioned factors, the telemonitoring approach used, whether education of the patient, use of structured phone contact or use of innovative technology, was important in the determination of patient's compliance compared to the associated socioeconomic factors.

## Discussion

Intervention factors used were determined to be effective in enhancing the compliance of heart failure patients to telemonitoring in comparison to usual care involving telemedicine without interventions. Interventions that involved the education and training of the patient led to a more significant enhancement of effectiveness in ensuring compliance. Monitored home self-care through cell phones had a less significant impact on the compliance of the heart failure patients. While this review and meta-analysis are in compliance with PRISMA, it maintains its originality as a study assessing and comparing various interventions to enhance telemonitoring adherence. Using a multi-approach comparison in this meta-analysis enabled the researcher to incorporate data from both direct and indirect interventions.

Regarding the topic of telemonitoring, abundant evidence currently available focuses on the comparison between the efficiency of telemonitoring versus normal care without telemonitoring of heart failure patients. However, this article aims to maintain a unique approach of identifying and determining the comparative efficiency of the various interventions used in enhancing compliance of heart failure patients to telemonitoring. The efficiency of the various interventional methods used involve evaluation of indicators including the patient reporting of daily measurements of ECG, blood pressure, and weight, the HF compliance questionnaire scores, the proportion of weekly submitted self-measurements, and increased use of healthcare resources. Among all these interventions it was determined that patients with better knowledge and training were more compliant as measured through the indicators. These findings confirm the outcomes of various studies and theories of adherence to medications in the management of diseases. Previous studies on heart failure patient compliance to telemonitoring reveal the importance of the implications of various techniques to enhance compliance. Currently, more innovative technology, other than telephone calls and the use of mobile phone applications is being investigated for possible future use. Accordingly, the use of artificial intelligence is being investigated to support clinical decision making and imaging interpretations by the patient [8]. While most of these techniques could be useful in monitoring heart failure patient's health, it is important to find easier ways that enhance compliance by the patient. Studies have indicated that increasing patient participation in telemonitoring and enhancing their compliance can be achieved through effective interactions between the patient and their physicians, and the outcomes include reduced hospitalizations and increased survival rates of the heart failure patients [8].

## Patient education/ telemonitoring training

The use of education or training of the heart failure patients in enhancing their compliance to telemonitoring was the best of the interventions used. Accordingly, education of the patients through the integration engaging psychosocial factors was important in ensuring that the telemonitoring process was more customized to the needs of the patients. To ensure effectiveness in compliance, education can be carried out in phases. The first phase involves the education of the patient regarding the pathophysiology of the condition. This phase includes using audiovisual information in demonstrating the various conditions involved in chronic heart failure, and its assessment. The second phase of the education process involves keeping a close contact with the patient through emails to inform or update them about the health risks associated with the condition, the need for vigilance, and instructions on the equipment of care. This phase is most likely conducted after discharge to facilitate self-care or the assistance by others. It is imperative that the education and training sessions for the heart failure patients is kept interactive and based on the ace of the understanding of the patient.

## Innovative technology

The use of improved technology was also another preferable option for enhancing patient compliance to telemonitoring. The use of cloud-based automatic feedback application systems is one of the innovative techniques that should be considered in enhancing the compliance of the patient to the telemonitoring process. Accordingly, the healthcare providers are able to monitor the progress of the patient with regard to the set thresholds of care. Upon achievement of certain thresholds through regular reporting, the automated system can send a congratulatory message to the patient, recommending and encouraging their compliance. Regardless, education and training were still key to the success of this intervention. The patients, before being discharged to use the innovative technology should be well trained and asked to choose their preferred methods of automated communication-calls, text messages and emails.

For both instances, whether education or use of innovative technology, research has identified the need for patient follow up to be key in ensuring adherence to telemonitoring is sustained. Follow up was not only important in ensuring that the telemonitoring techniques were reinforced regularly, but also helped in assessing changes in the clinical characteristics of the chronic heart failure disease.

## Compliance assessment

To assess the progress of compliance, the patients can be monitored for various factors including self-reporting of daily measurements of healthcare parameters, use of healthcare resources and the actual usage of the technology used in telemonitoring. Improvements in the frequency and amounts of self-reporting indicate that there is improved compliance, while a decline in self-reporting could imply non-compliance. Secondly, an increase in the use of healthcare resources allocated for self-care and the telemonitoring equipment could also indicate increased compliance by the heart failure patients.

## Factors affecting compliance

Various factors determined to implicate compliance in patients include patient education, their age and the use of innovative techniques. Research indicates that patients with social support from the family, caregivers and their friends were more likely to be

encouraged and their telemonitoring regimen reinforced. As a result, these individuals were more committed to accomplishing the objectives of the telemonitoring programs they were assigned. To the contrary individuals without support of their families, friends and other caregivers were more likely to be less committed to the telemonitoring programs due to lack of encouragement or motivation to reinforce the instructions by the healthcare provider.

Unless appropriate the patients were adequately educated and trained on the appropriate application of the telemonitoring program, patients without appropriate education are less likely to comply to the telemonitoring programs. Accordingly, compliance is associated with literacy and the ability to understand and effectively interpret the various processes involved in the telemonitoring process.

In addition to socio-economic factors, patient related factors such as age and were also reported to implicate compliance. Accordingly, elderly was more likely to suffer cognition and physical impairments implicating their ability to effectively understand and interpret the processes involved in the telemonitoring program. Impairments in the body that could hinder seeing, hearing and moving, could also limit the engagement of the patient in the telemonitoring program.

## Conclusion

Therefore, abundant evidence currently available focuses on the comparison between the efficiency of telemonitoring versus normal care without telemonitoring of heart failure patients. Currently more innovative technology, other than telephone calls and the use of mobile phone applications is being investigated for possible future use. Accordingly, the use of artificial intelligence is being investigated to support clinical decision making and imaging interpretations by the patient. Regardless of the aforementioned factors, the telemonitoring approach used, whether education of the patient, use of structured phone contact or use of innovative technology, was important in the determination of patient's compliance compared to the associated socioeconomic factors. Unless appropriate the patients were adequately educated and trained on the appropriate application of the telemonitoring program, patients without appropriate education are less likely to comply to the telemonitoring programs. Accordingly, compliance is associated with literacy and the ability to understand and effectively interpret the various processes involved in the telemonitoring process. Increasing patient participation in telemonitoring and enhancing their compliance can be achieved through effective interactions between the patient and their physicians, and the outcomes include reduced hospitalizations and increased survival rates of heart failure patients.

## Conflict of Interests

The authors declare no conflicts of interest.

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