The Feasibility of the Heart Failure Mobile Phone Aide Application (Android Apps.) on Self-Management Measured by Improved Physical Function and Reduced Hospital Admissions Related to Heart Failure in Thailand

A DISSERTATION

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For the Degree
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By
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Washington, D.C.

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The Feasibility of the Heart Failure Mobile Phone Aide Application (Android Apps.) on Self-Management Measured by Improved Physical Function and Reduced Hospital Admissions Related to Heart Failure in Thailand

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Heart failure (HF), deterioration of heart function, is a serious chronic disease in Thailand. It affects patients’ physical health, emotional state, and life expectancy. Patients who poorly self-manage their HF can expose themselves to unnecessary and dangerous risk factors, causing them to be hospitalized or readmitted to the hospital. Most patients with HF need additional resources to assist them in monitoring their signs and symptoms, the side effects of their medications, the administration of their medications, and the control of fluid and sodium levels. Aide apps on mobile phones aim to improve self-management in patients with HF, helping them improve physical function and decrease hospital readmission rates.

The purpose of this study was to test whether there were differences in readmission rate, physical function, pitting edema, and blood pressure between patients with HF who used the Heart Failure Aide Application (HFAA) and patients with HF who received the standard treatment. The study was based on a quasi-experimental design with repeated measures for two groups in a pretest-posttest design. It used self-management in chronic disease as a theory framework.

The project method involved introducing the HFAA to enhance self-management in patients in Thailand who have HF. The 120 participants were divided equally into a control group and an implementation group. The intervention group used the HFAA, and the control group received standard care from the hospital over the next three months. This study used descriptive statistics, bivariate analysis, and repeated measures of multivariate analysis of covariance (MANCOVA) to detect differences between the mean values across four
timeframes (the baseline, 30 days, 60 days, and 90 days) for each measurement. The independent sample t-tests assessed differences in hospital readmission rates between the two groups.

The findings supported the first, third, and fourth hypotheses. Thai patients with HF who used the HFAA demonstrated more improvements in the 6MWT and experienced fewer hospital readmissions. And, fewer patients who used the HFAA experienced episodes of pitting edema compared to those who did not use the mobile app. The second hypothesis was not supported. That is, Thai patients with HF who used the HFAA did not demonstrate any differences in systolic blood pressure and diastolic blood pressure compared to those who did not use the mobile app. As the results showed, patients with HF who received the HFAA had lower readmission rates, fewer episodes of pitting edema, and better scores on the 6MWT than those who received the standard treatment. These findings indicate a strong potential for patients with HF to use the HFAA.
This research project by Chittraphorn Suthipong fulfills the requirement for the doctoral degree in Doctor of Philosophy approved by Janice Agazio, PhD, CRNP FAANP, FAAN, as Director, and by Sandra O’Brien, Ph.D., CNE, CRNP-F, PHCNS-BC, RN and Rachanee Sunsern, Ph.D., RN. as Readers.

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Dr. Rachanee Sunsern, PhD., MS.,BA,RN, Reader
DEDICATION

I dedicate this work to my family without whom this would not have been possible.

To my parents, for their endless and unconditional love. To my husband, for his great support and always teaching me to put my best for my work. To my daughter, who is the best gift God has ever given me.
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This work was only possible with the support and help of many people to whom I will always be grateful. I wish to express my appreciation to many individuals who provided invaluable assistance for this doctorate project. My sincere thanks to my supervisor Dr. Janice B. Griffin Agazio for her time, effort and guidance throughout a tedious learning process. I also would like to thank my committee members Dr. Sandra O’Brien, and Dr. Rachanee Sunsern for their valuable support, insightfulness and guidance throughout this work. In addition, I would like to express my sincere gratitude to Wattana Wongtheptien (M.D. Cardiologist Chiangrai Regional hospital) for his incredible patience, great recommendations and unlimited support throughout the application-programming phase of the project. I am truly grateful to other members of the project team, Wathit Phonlit (programmer) for his contributions and support in design and development of the mobile phone application. I would also like to thank the heart failure clinic team who devoted their time and efforts for the completion of this project. Of course, this project definitely could not have been completed without the cooperation of the patients who have taken the time to participate in my study and provide me with valuable data. I also would like to thank all of my friends for their cheerful and emotional support. Finally, I am thankful for my family for all their support throughout my studies. I am more than blessed to have them in my life.
CHAPTER I: The Problem

Background

In Thailand, the prevalence of patients with heart failure (HF) has dramatically increased in the last two decades. Because it continues to rise every year, it has been identified as a major health problem (Ministry of Public Health of Thailand, 2012). Guo, Lip, and Banerjee (2013) reported that the mortality rate from HF in Thailand was at 4.60%, and the rate of hospital readmission within 30 days was 14.1% in 2010. Each year, the Thai government spends a large amount of the budget caring for patients with HF due to the enormous medical and treatment costs and because of hospital readmissions (Srisuk, Cameron, Ski, & Thompson, 2014). HF is a serious chronic disease in Thailand (Jeon, Kraus, Jowsey, & Glasgow, 2010).

Effects of Heart Failure

HF is the end state of cardiac disease. HF affects patients’ physical health, emotional state, and life expectancy due to the deterioration of heart function (The American Heart Association (AHA), 2016). The physically undesirable symptoms of HF include dyspnea, fatigue, lower extremity edema, cough, weight gain due to fluid overload, polyuria as result of diuretics, and sleeping problems (AHA, 2016; Fleming, 2012). These symptoms affect quality of life (QOL), can cause hospital readmissions as result of severe complications and poor prognosis that increase healthcare costs, and eventually lead to mortality and morbidity (Jeon et al., 2010). The reasons for hospital readmissions are frequently related to reversible factors, including complex medication regimens, poor adherence to medications, inadequate follow-up care, and poor communication between healthcare providers (DeLaCruz, 2015). More importantly, inappropriate treatment, stress, and poor self-management of HF can cause a patient’s death (Jeon et al., 2010).
Poor Self-management of Heart Failure

Pressler et al. (2009) found evidence that poor self-management in patients with HF (e.g., failure to maintain fluid control, follow a low-salt diet, and take prescription medications) can expose patients to unnecessary and dangerous risk factors, resulting in HF hospital readmission. Evangelista and Shinnick (2008) reported that more than 50% of readmissions of patients with HF result from non-adherence to self-management. Moreover, inadequate patient self-awareness, ineffective self-management, and the complexity of body system interactions in HF create poor health outcomes for patients with HF, making progression of the disease extremely challenging to control (Bradley et al., 2013). Thus, as Gardetto (2011) found, poor HF self-management is a main cause of death and readmission. Furthermore, a lack of effective strategies to support patients with HF at home is one factor of hospital readmission (Alnosayan, 2015). Therefore, patients need effective approaches to manage HF and help with early detection of symptoms of disease exacerbation so that treatments can be initiated for proper prevention of hospital readmission and death (Centers for Disease Control and Prevention (CDC), 2012). Patients with HF also have a major obligation to take care themselves by taking their medicine, exercise regularly, monitor symptoms and weight, and respond to changes in symptoms. They can accomplish better self-care by adjusting the dosage of their diuretic or contacting their doctor immediately if symptoms worsen (Ponikowski et al., 2014). However, most patients with HF admitted that they did not monitor their weight and exercise and did not follow medical advice, even though they received information and education from the hospital (Ponikowski et al., 2014). As a result, these patients experienced delays in decision-making after symptoms worsened. Therefore, education that is more effective must also be considered to improve outcomes. Furthermore, most patients with HF need other resources to help monitor their symptoms,
understand the side effects of medications administer medication, control fluid and sodium levels, and assist with physical disabilities (Pressler et al., 2009).

**Supporting Patients with Heart Failure**

The AHA suggests that patients with HF need education and close monitoring to improve treatment adherence (AHA, 2015). Patients with HF require assistance and formal care from healthcare providers and informal care at home to help administer medications, control fluid and sodium levels, monitor side effects of medications, and assist with any physical disabilities (Alnosayan, 2015). Although nurse interventions have been beneficial for managing HF, their implementation remains low due to limited clinical resources that are available to monitor and manage patients at home, the limited number of nurses, and the growing needs of patients. Furthermore, the patients with HF in underserved rural and urban areas in Thailand often have limited access to heart clinics (Ministry of Public Health, 2012). To overcome this inequality or access barrier, the AHA has recommended the use of mobile technology, or telehealth, to assist healthcare providers in caring for, and enhancing self-management for, patients with HF in rural areas (CDC, 2012).

**Mobile Phone Technology and Self-management in Patients with Heart Failure**

Mobile technology has been identified as an effective mechanism for reducing readmission and mortality rates, while improving QOL and reducing costs because it enables the information exchange between healthcare providers and patients (Inglis, Clark, McAlister, Stewart & Cleland, 2011). As Henderson et al. (2013) reported, “the patients with long term conditions who did not use telehealth spent an average of US$258.80 more in out-of-pocket expenses than those who used telehealth. It is also a cost-effective approach because it allows a limited number of providers to reach the growing number of patients with HF” (Kvedar, Coye, & Everette, 2014, p. 3). Mobile phone technology is usually used to
collect physical measurements, such as weight and blood pressure, and transmit the data to healthcare providers (Alnosayan, 2015). One advantage is its ability to automatically record and analyze data to identify a patient’s risk, provide suggested interventions, and alert the patient if they need to immediately go to a hospital (Alnosayan, 2015; Zhang et al., 2013). Thus, mobile phone technology might be an important way to reach the socioeconomically disadvantaged and promote self-management in patients with HF at home, especially in rural areas (Goldstein et al., 2014). In Thailand, mobile phone use has grown rapidly; over 90% of Thai people are now estimated to own a mobile phone (Ministry of Public Health, 2012). Nonetheless, mobile phone apps use has not yet been implemented in Thailand. The healthcare system in Thailand needs to devise mobile phone strategies because of the potential for mobile phones to enhance self-management for patients with HF. These mobile phone applications can help them in their daily routines by increasing physical function, improving QOL, and decreasing hospital readmission rates.

Thus, goal of this study was to empower patients with HF to manage their own health by using mobile aid apps. A mobile phone aid app assisted patients with HF by calculating diuretic prescriptions, controlling fluid consumption, and monitoring possible signs of potential emergency threats. Therefore, an app, such as the Heart Failure Aid Application (HFAA) used in this study, could improve self-management of patients in Thailand who have HF, helping them gain physical function and decrease hospital readmission rates. Lorig & Holman’s (2003) model of self-management of heart failure (SMHF) was the theoretical framework that guided the study. The aim, hypotheses, and definition of each variable, including physical function was measured by a six-minute walk test (6MWT), readmission rates, blood pressure, and pitting edema.
Statement of the Problem

Poor self-management in patients with HF (e.g., lack of fluid control, failure to maintain a low-salt diet, and prescription non-compliance) is likely to lead to unnecessary and dangerous exposure to risk factors that can cause a patient with HF in Thailand to be hospitalized or readmitted (Ministry of Public Health of Thailand, 2008). One study demonstrated that most patients with HF need further resources to assist in monitoring their signs and symptoms, the side effects of medications, the administration of medications, and the control of fluid and sodium levels (Pressler et al., 2009). Mobile phone apps are a way to enhance self-management in patients with chronic diseases by offering ways to achieve effective monitoring and analysis, identify risk for patients with HF, prevent exacerbations, improve QOL, and decrease hospital admissions (Alnosayan, 2015). Although mobile phone apps are used and accepted in many healthcare settings worldwide, their use has not yet been implemented in Thailand. Therefore, the healthcare system in Thailand needs to find mobile phone strategies because they have the potential to enhance self-management for patients with HF in their daily routine to increase physical function status, improve quality of life, and decrease hospital readmission.

This study used the self-management of chronic illness (SMCI) theory as the theoretical framework for this study because the study’s purpose was to test the feasibility of HFAA for self-management among patients in Thailand who have HF. Riegel, Jaarsma, and Strömberg (2012) described SMCI as a middle-range theory, with the following key concepts:

- Self-care maintenance refers to the behaviors of chronic illness patients to promote well-being or to maintain physical and emotional stability.
- Self-care monitoring is the self-assessment of bodily changes as signs and symptoms.
• Self-care management is the individual analysis and response to monitoring signs and symptoms to determine the necessary intervention. For instance, lower extremity edema and dyspnea might require increasing diuretic doses (Riegel et al., 2012, pp. 4–12).

Each concept is related to and flows into the other: self-care maintenance provides the opportunity for self-care monitoring, and self-care monitoring provides information for self-care management of worsening symptoms (2012).

The SMCI theory encompasses six skills (Lorig & Holman, 2003, pp. 4–5):

• Problem-solving: Patients are taught skills to solve their health problems, including defining the problem, listing possible solutions, gathering recommendations from formal and informal caregivers, implementing the solution, and evaluating the outcomes (Lorig & Holman, 2003, pp. 1–6).

• Decision-making: Patients need to make decisions regarding their health condition (Lorig & Holman, 2003, p. 6). For example, they must decide what they should do when certain signs and symptoms are present. For patients to enact decisions appropriately, they must have adequate knowledge about their health condition.

• Resource utilization: This self-management skill involves supporting and teaching patients how to use information and materials and to seek help from many resources (Lorig & Holman, 2003). For example, a set of instructions for the HFAA teaches patients with HF how to use the app.

• Formation of a patient-provider partnership: The role of healthcare providers is to provide care for and advise patients (Lorig & Holman, 2003). Also, patients should be able to accurately provide information about any worsening conditions with their healthcare providers (Riegel et al., 2012).
• Action planning: Patients need to know how to plan for action. For example, they must understand and plan for self-management, including learning how to change their behavior, such as exercising regularly, making medication adjustments, controlling their diet and fluids, and heeding emergency signs to return to the hospital (Lorig & Holman, 2003).

• Self-tailoring: Patients must use their knowledge and self-management skills and implement them to achieve personal self-care that is appropriate or works best for them (Lorig & Holman, 2003, pp. 6-7). The concept of self-management has three main assumptions:
  o Self-management problems and disease-related tasks in different chronic disease patients are not different.
  o Improving self-management tools for patients will enhance their health status.
  o Behavior changes, such as exercising regularly (Lorig & Holman, 2003).

According to the SMCI theory, self-management can help patients change their behaviors and improve their confidence and skills in managing their condition to optimize clinical outcomes.

The SMCI makes the following assumptions:

• “Patients accept responsibility to manage or co-manage their own disease conditions.”

• “Patients become active participants in a system of coordinated health care, intervention and communication.”

• “Patients are encouraged to solve their own problems with information, but not orders, from professionals” (Lorig & Holman, 2003, p. 6).

The SMCI theory is clearly a consistent, specific, and useful theory. It is comprehensively generalizable to all patients with chronic illness (Riegel et al., 2012).
Mobile technology is an important part of promoting self-care management (Ponikowski et al., 2014).

In this study, using HFAA, the researcher taught the six self-management skills to patients with HF. The app eased patients’ challenges in daily living with HF. For example, the app taught patients how to calculate their diuretic medication dosage, monitor fluid intake and output, and maintain fluid balance.

For decision-making, the app provided comprehensive information about a salt-restricted diet, identification of important signs and symptoms with follow-up management, medication therapy with readjustments in dosing, and fluid intake and output. The app supported patients with HF in managing the adverse signs and symptoms of the condition and avoiding complications, such as fatigue, edema, and dyspnea. It also included hospital warning signs.

For resource utilization, the app provided information regarding emergency contact numbers, support groups, and access to providers. It educated them on how to use resources efficiently. With this important information, patients could interpret and then use available resources.

The HFAA helped patients with HF to form partnerships with their healthcare team. For action planning, the HFAA taught patients with HF how to plan for their daily living needs. For example, it helped patients with HF to make medication and fluid adjustments by auto-calculating diuretic doses and daily fluid intake. It also helped them to identify or detect the earliest signs of life-threatening deterioration so that they could return to the hospital immediately.

Finally, for self-tailoring, patients used HFAA to assist them in the challenges of their daily living and to prevent HF complications. “Successful self-management is driven by patient-defined problems and fosters the mastery of skills in problem-solving, action
planning, decision-making, and support building through an iterative process” (Lorig & Holman, 2003, p. 265). SMCI has had beneficial effects on patients with HF adherence to a prescribed medical regimen, and because of this, hospital readmissions due to HF complications have decreased, and premature death has declined (Black et al., 2014). Also, use of the six self-management skills has resulted in improvement in their use and has assisted patients in adjusting to the limitations caused by their disease and in improving their QOL. Healthcare providers have promoted individually tailored SMCI activities via mobile technology to support patients with HF in management of their condition (DelaCruz, 2015).

This study proposed four dependent variables: (a) physical function, (b) readmission, (c) pitting edema, and (d) blood pressure. Measurement of physical functioning in this study used the 6 minute walk test (6MWT) (Lorig & Holman, 2003), blood pressure and pitting edema as measurements. Vuckovic & Fink (2012) stated that the 6MWT is safer and easier to administer even in patients with severe HF (New York Heart Association (NYHA) class IV). The 6MWT better reflects activities of daily living and has been widely used to monitor HF progression, consider management or treatment effects, and forecast readmission and mortality (Vuckovic & Fink, 2012). It is an appropriate assessment for quantifying functional capacity and forecasting morbidity and mortality in patients in Thailand who have HF (Suwanachiiy et al, 2010). Blood pressure was taken at the baseline, then at 30 days, 60 days, and 90 days. Pitting edema measurements were averaged based on results from days 46 to 90.

Self-efficacy (variable level: dependent variable) refers to the “beliefs in one’s capabilities to organize and execute the course of actions required to produce given attainments and base future research on self-protective acts related to lifestyle” (Lorig & Holman, 2003, p. 266). Self-efficacy involves solving a problem, planning, collaborating, and
Figure 1. Self-management framework for patients with HF, applied from Lorig and Holman (2003).

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Problem solving</th>
<th>Decision making</th>
<th>Resource utilization</th>
<th>Forming of a patient-provider partnership</th>
<th>Taking action</th>
<th>Self-tailoring</th>
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<tr>
<td>Patients can understand problems and offer solutions.</td>
<td>Patients can make decisions to care for themselves.</td>
<td>Patients can use self-managed information for their own care.</td>
<td>Patients can accurately provide information about any worsening conditions with their healthcare providers.</td>
<td>Patients know how to plan for self-management and action.</td>
<td>Patients have individual self-management skills.</td>
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Concept

Self-management

Variables

Physical function

Empirical-indication

6MWT  BP  Pitting edema

Heart Failure Aide Application (mobile apps)

Hospital admissions related to HF
finding mental support. It also involves the reactions that are related to a change in circumstance or achieving a goal (Lorig & Holman, 2003).

The relationships among the variables in this study are depicted in Table 1.

Table 1.  
*The variables in this study*

<table>
<thead>
<tr>
<th>The study groups</th>
<th>Screening variable</th>
<th>Dependent variable for physical functional status</th>
<th>Covariate</th>
<th>Independent variable treatment</th>
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<th>Independent variable treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (standard care)</td>
<td>Cognitive function: acceptable MiniMental</td>
<td>Hospital readmission rates: 1. 6MWT 2. Blood pressure 3. Pitting edema</td>
<td>Age Education level</td>
<td>Usual intervention: Text messages</td>
</tr>
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</table>

**Statement of Purpose**

The purpose of this study was to examine the feasibility of HFAAs on self-management among patients in Thailand who have HF. The Software Industry Promotion Agency (SIPA) of the Thai government has required healthcare systems to begin using mobile apps to assist patients in searching and accessing health information (SIPA, 2015). This study was a quasi-experimental pretest-posttest design that compared the effects of an HFAA on hospital readmission rates and the functional status of patients with HF. The objective of this study was to compare hospital readmission rates and functional status between the intervention and control groups.
Research Question and Hypotheses

For this study, I set out to determine how Thai patients with HF who use the HFAA mobile app compare to patients with HF who do not use the mobile app. The following hypotheses guided this study measuring the differences:

H1: Thai patients with HF who receive the HFAA will demonstrate improved results for the 6MWT compared to Thai patients with HF who do not receive the mobile app.

H2: Thai patients with HF who receive the HFAA will demonstrate lowered blood pressure compared to Thai patients with HF who do not receive the mobile app.

H3: Fewer Thai patients with HF who receive the HFAA mobile app will have pitting edema compared to Thai patients with HF who do not receive the mobile app.

H4: Thai patients with HF who receive the HFAA will demonstrate lowered hospital readmission rates compared to Thai patients with HF who do not receive the mobile app.

Definition of Terms

This study includes several key terms.

Heart Failure

*Theoretical definition.* Heart failure is the final state of heart disease in which the heart cannot maintain its functional capacity due to advanced conditions where the cardiac function is inadequate to pump cardiac output (American Heart Association, 2015).

*Operational definition.* A cardiologist diagnoses heart failure in patients when they have grade II heart failure, based on the NYHA classification.
Heart Failure Aide Application

*Theoretical definition.* An HFAA is a software or computer program designed to work on smartphones, mobile phones, and tablets (Ventola, 2014).

*Operational definition.* An HFAA is an Android app that is free to download on a mobile phone. The app was established with help from the education program for patients with HF in Thailand who supports patients with HF by helping them care for themselves at home. The app is composed of education on HF disease, diuretic computing, fluid intake computing, hospital warning signs, and emergency interaction.

Readmission Rate

*Theoretical definition.* The readmission rate is “patient admission to a hospital within 30 days after being discharged from an earlier hospital stay” (Mayo Clinic, 2016, p.1).

*Operational definition.* The readmission rate is the admission of a study participant to the inpatient department at the facility hospital within 30 days of being previously discharged.

Physical Function

*Theoretical definition.* Physical function classifies a patient’s symptoms according to “the NYHA functional classification. It places patients in one of four categories based on their limited level of physical activity” (AHA, 2016, p.1).

*Operational definition.* Physical function refers to a participant’s ability to walk as measured by the 6MWT. 6MWT is a tool to test the functional capacity of people with HF. It has been verified to be consistent, cheap, harmless and easy to apply (Ulrich et al., 2013). In this study, it is an assessment tool to quantify the functional exercise ability of patients with HF.
Self-management

_Theoretical definition._ Self-management is a patient’s decisions and behaviors to undertake and manage daily tasks to maintain health conditions and well-being through the lifetime of a sickness (Riegel, Jaarsma, & Stromberg, 2012).

_Operational definition._ Self-management refers to the behaviors of patients with HF to manage and maintain their health conditions.

Blood Pressure

_Theoretical definition._ Blood pressure is the exerting pressure of circulating blood. It is typically stated in terms of the systolic pressure over diastolic pressure; millimeters of mercury (mm Hg) is used for measurement (AHA, 2016).

_Operational definition._ Blood pressure is a participant’s blood pressure. The participant must take his or her blood pressure each morning.

Pitting Edema

_Theoretical definition._ Pitting edema is defined as observable “swelling of body tissues due to fluid accumulation that may be demonstrated by applying pressure to the swollen area, such as by depressing the skin with a finger (Medicinenet.com, 2016, p. 1).

_Operational definition._ Pitting edema refers to the pressure that a patient with HF applies with a finger to his or her leg every day to test indentation.

Significance of the Study

The failure to properly manage HF may lead to hospital readmission within 30 days and patient death (Guo, Lip, & Banerjee, 2013). Normal factors that contribute to unfavorable outcomes are poor self-care, poor medical adherence, and lack of follow-up with the hospital. These factors are the result of a low quality of life, stress, physical dysfunction, a lack of
knowledge and understanding about treatment and medication, and low self-management skills (Jeon, Kraus, Jowsey, & Glasgow, 2010). In 2010 in Thailand, the hospital readmission rate in patients with HF was 14.1%, and the mortality rate from HF was 8.8% (Guo, Lip, & Banerjee, 2013). The Thai government, the main payer in health care, has identified hospital readmission as a major factor in pushing the healthcare budget skyward (Ministry of Public Health, 2012). Because of these issues, the Thai government also needs effective strategies to manage HF. Self-management can be a significant approach in the early phases of decompensating to avoid re-hospitalization due to the complications and long-term consequences of HF regimens (Jovicic, Holroyd-Leduc, & Straus, 2006, p. 43).

Unfortunately, many patients lack self-care skills, which they require to monitor worsening symptoms, take complex medicines, control diet, and commit to physical activity to control signs and symptoms (Van der Wal & Jaarsma, 2008). Most patients with HF reported taking medications every day, but admitted to failing to monitor daily weight, exercise regularly, and adjust inaccurate diuretic doses (Henderson et al., 2013). Self-care education is a major priority, but it must be more carefully designed because even patients with HF that received education have reported delaying care when worsening symptoms occurred (Ponikowski et al., 2014). As DelaCruz (2015) stated, patients with HF challenge medical use because of their lack of skills and knowledge to manage complex medical regimens and make diuretic adjustments. Therefore, supporting patients to manage themselves is a crucial element for patients who need chronic disease management.

In Thailand, self-management could decrease the readmissions rate, cost, and improve the quality of life in chronic disease. It is also fundamental and beneficial for managing HF (e.g., nurse interventions), but many patients complain of a lack of support at home (Triamchanchoochai, Yamwong, & Sritara, 2009). Furthermore, the challenge with intervention in Thailand might be related to the limited number of healthcare providers and
the lack of clinical resources to care for the rising number of patients with HF (Alnosayan, 2015). These providers and resources help to support, monitor, and manage patients with HF at home. Patients with HF require other strategies to support effective self-care management of their health conditions and close monitoring at home, particularly to monitor and detect worsening conditions (Triamchanchoochai, Yamwong, & Sritara, 2009).

Therefore, technology resources are needed to help patients monitor symptoms, note the potential side effects of medications, document the administration of medication, control their fluid and sodium levels, and assist with any physical disabilities (Pressler et al., 2009). Mosa, Yoo, and Sheets (2012) stated that using home care technology, such as mobile health apps, has potential benefits in increased quality of care, improved patient self-care management, reduced costs and hospital readmissions, and prevention of premature death. Additionally, Chutimaskul (2014) suggested that using a smartphone can enhance self-management for patients in Thailand who have chronic HF and reduce their risk of re-hospitalization. However, in practice, scientific study has not been thoroughly conducted on using mobile phones for home monitoring or supportive care of patients with HF.

The gaps of evidence show a need for more research to develop medication adherence and self-management skills for patients with low health literacy. Hence, to address the gaps in the literature, the HFAA mobile phone app was enhanced with patient self-management to decrease physical burdens from HF and improve medication adherence to complex regimens among patients in Thailand who have HF.

As Franklin (2015) stated, social media, mobile-based interventions, and self-tele-monitoring tools have the potential to greatly improve health outcomes and QOL in patients with HF. O’Brien et al. (2011) reported that smartphone apps have been used to prevent pediatric asthma at home and to engage parents to take a more active role in monitoring their child’s asthma at home. Related work points to the potential for e-health to be integrated into
patient social networks to optimize self-management. Likewise, Zhang (2013) reported that mobile technology is useful because it enables patients to: (1) manage and care for their health conditions at home in a cost-effective way, (2) identify their risk factors, and (3) learn about suggested interventions for solutions (Kvedar, Coye, & Everette, 2014).

In this study, the purpose of the mobile app was to support patients with HF in controlling their healthcare at home. It assisted them in computing their individual medications and fluid intake. Moreover, in case of emergency, patients with HF who used the HFFA mobile app could consult their healthcare team directly. Thus, this study aimed to investigate the effect of the HFFA for patients in Thailand who have HF to enhance self-management, decrease physical burdens, and handle complex medication regimens.

In summary, the results of this current study provide insight about the factors that can increase the self-management skills of patients with HF. Having these skills might decrease hospital readmission in patients in Thailand who have HF in Thailand.

Assumption

This study made the following assumptions:

- Participants pass the Mini-Mental State Examination – Thai version 2002.
- Participants own a smartphone.
- Participants install the HFFA on their smartphone and use their smartphone to calculate their daily intake of diuretics, salt, and fluid.

Summary

HF patients in Thailand require close monitoring, frequent assessments, management of multiple medications, and support to help prevent clinical deterioration. Furthermore, patients with HF desire other strategies, such as mobile technology, to assist in their self-care (Alnosayan, 2015). The HFFA can be an important device to support patients with HF at
home. However, studies on smartphone apps to help care for patients with HF at home have not been thoroughly conducted. An HFAA could enhance patient self-management, decrease physical burden, and assist with complex medication regimens among patients in Thailand who have HF. The study aimed to demonstrate that the HFAA can assist patients with HF in managing their conditions and demonstrate positive results in lowering hospital readmission rates.
CHAPTER II: Review of Literature

The purpose of this study was to investigate the feasibility of the Heart Failure Application Aide (HFAA) on self-management among patients with HF in Thailand. The independent variable was the HFAA. The dependent variables included (a) physical function, (b) readmission rate, (c) blood pressure, and (c) pitting edema. Physical function was measured by the six-minute walk test (6MWT). This study recorded the hospital readmission rate of participants who have HF at three months after using the HFAA. The mobile application recorded daily blood pressures (BP) and pitting edema measurements.

I used the self-management of chronic illness (SMCI) theory as the theoretical framework for this study because the study’s purpose was to test the feasibility of the HFAA for self-management among patients in Thailand who have HF. According to our review of the relevant literature, the purpose of the HFAA is to enhance self-management, which reduces physical burden under a complicated medication regimen among patients in Thailand who have HF. The literature review of this study includes the topics of:

- self-management in heart failure;
- pathophysiological features of HF;
- physical burden in heart failure;
- complex medication regimen in heart failure;
- patients with HF in Thailand; and
- mobile health apps for self-management of patients with HF.

A review of literature performed for the proposed research study was confined to theoretical and empirical research that was published 2003 – 2016 with key words, such as self-
management, application through Cumulative Index to Nursing and Allied Health Literature (CINHAL), PubMed, Medline, ProQuest, American Heart Association (AHA), Ministry of Public Health, and the Centers for Disease Control and Prevention (CDC).

**Self-management in Heart Failure**

At the concept level, self-management is defined as “daily self-care behaviors in managing the disease and optimizing clinical outcomes” (Lorig & Holman, 2003, p. 5). The gold-standard of patient self-management of heart failure (SMHF) would reduce symptoms and decrease healthcare costs, while increasing positive clinical outcomes. Lorig and Holman (2003) and Riegel, Jaarsma, and Stromberg (2012) defined self-management as an individual’s ability to engage in “problem solving, decision making, resource utilization, formation of patient-provider partnerships, action planning and tailoring of daily activities” to accept and manage daily care. As a result, the patient could experience a changing lifestyle and well-being over the period of sickness. Rigel, Dickson, and Faulkner (2015) stated that self-management is a realistic decision-making method that influences activities that maintain physical function, assists in the perception of warning signs, and directly affects the control of a patient’s symptoms.

Evangelista and Shinnick (2008) argue that over 50% of hospital readmissions of patients with HF are a result of their non-adherence to self-management. Other causes are inadequate patient awareness and ineffective self-management, such as a lack of exercise or uncontrolled sodium intake (Jeon et al., 2010). The complexity of body system interactions in HF and unsuccessful self-management techniques create poor health outcomes in patients with HF because the disease progression is extremely challenging to control (Bradley et al., 2013). Adherence to complex medical treatments can become overwhelming due to the difficulties of
living daily with a chronic illness. Therefore, poor self-management of HF was defined as a main cause of HF complications that include death and hospital readmission (Toback & Clark, 2017).

Medical Complexity

A complex medicine regimen is a main task and challenge for patients with HF. These patients require regular follow-up, diet and fluid restriction, and monitoring of their lifestyle changes (Ditewig, Blok, Havers, & van Veenendaal, 2010). Riegel, Dickson, Goldberg, and Deatrick (2007) conducted a qualitative study by interviewing 29 patients with HF about their self-care skills. The study found that only 10% of patients with HF were skillful at self-management. This study illustrates the need for patients with HF to increase their self-management skills. Thus, to increase the positive clinical outcomes for patients with HF, an understanding of self-management in patients with HF is an important first step (Rigel, Dickson, & Faulkner, 2015).

Gardetto (2011) indicated that self-management in patients with HF might lead to better health outcomes. However, self-management in patients with HF usually involves behavioral adaptation. An example of a type of behavior modification is teaching patients with HF to understand, observe, and monitor the signs and symptoms of their disease. Other behavior modifications include complex medical regimens, such as restricting sodium and fluid intake and maintaining healthy behaviors, such as exercise consistency. Patients with HF have been considered good candidates for the greatest individualized management training (e.g., restricting oral fluid to 1.5 liters per day), due to their symptoms regularly changing (Bradley et al., 2013). Moreover, because of the complexity of HF regimens, careful diet management and scrupulous
weight control are critical in preventing hospital readmission (Nieuwenhuis, Jaarsma, Van Veldhuisen, & Van der Wal, 2012).

Jonkman et al., (2016) indicated that self-management for U.S. healthcare patients is vital to accomplishing the greatest patient outcomes. The benefits they gain include, but are not limited to, decreased mortality and an increased quality of life (QOL). The AHA stated that, to enhance self-management in patients with HF, nurses need to encourage patients to consistently take medicines, monitor HF symptoms, and regularly follow-up with doctors as needed (Toback & Clark, 2017). Moreover, the CDC defined self-management as a main behavior to improve health outcomes in patients with HF (Rigel, Dickson, & Faulkner, 2015). The use of self-management strategies, including weight monitoring, consistent and compliant daily use of medicines, and adherence to a low-salt diet, have indicated beneficial outcomes patients with HF (Van Do, Barnason & Tran, 2015). Nevertheless, the recommended behavior changes in the day-to-day activities of patients with HF require both problem-solving skills and decision-making skills. Patients with HF have the primary responsibility to incorporate the multiple medical regimens that are required for HF treatment into their everyday lives for self-management (Toback & Clark, 2017). The main responsibilities and requirements of self-management in patients with chronic diseases, such as HF, are “monitoring daily weight, taking prescribed medications, following sodium control, and fluid restriction, exercising regularly, and keeping follow-up appointments strictly” (Van Do, Barnason, & Tran, 2015, p. 1). Therefore, supporting patients with HF to manage their self-care is a crucial element of positive health outcomes.
Role of Healthcare Providers

Self-management is broadly recognized as a vital element of multidisciplinary teams. The effectiveness and efficiency of self-management relies on the support that individuals receive on being knowledgeable about their illness, being active in their self-care, and increasing all possible self-management skills (Rigel, Dickson, & Faulkner, 2015). Self-management in HF is dependent on adherence to prescribed medical regimens, such as controlling sodium and fluid intake daily, exercising, and taking medication regularly (Gardetto, 2011). These strategies of self-management could decrease the rate of hospital readmission and improve the QOL in patients with HF (Jovicic, Holroyd-Leduc, & Straus, 2006). Thus, healthcare providers should promote self-care management activities by using tailored approaches and related prevention and promotion strategies (Chitimaskul et al., 2014).

Role of Technology

Toukhsati, Driscoll, & Hare (2015) claimed that electronic health self-management interventions could improve symptom control, monitoring in chronic disease, and health outcomes. Lorig, Ritter, Laurent, and Plant (2006) examined the feasibility of the web-based program called The Internet Chronic Disease Self-Management Program (ICDSMP) on problem-solving, action planning, and managing difficult emotions in chronic patients. The study found a significant decline in hospital emergency incidences after the clients accessed the ICDSMP for 24 weeks. Also, Chitimaskul et al. (2014) reported that mobile phone technology has been used to improve patients’ awareness and knowledge, promoting the QOL for people in Thailand.
**Improved Outcomes**

Patients in Thailand who have HF could prevent premature deaths and reduce hospital readmission if they were educated to identify the signs and symptoms of their disease. They could then change their behaviors to undertake and manage daily tasks and practice healthy self-management and medical adherence (Chitimaskul et al., 2014). Therefore, self-management is considered a basis to improve HF outcomes. Unfortunately, patients with HF could be limited by the complex demands of maintaining their daily regimen, self-awareness of symptoms and medication adherences, even though considerable evidence supports the idea that patient medication adherence reduces hospital admissions and mortality risk (Riegel, Jaarsma, & Stromberg, 2012). Allen, Vassilev, Kennedy, and Rogers (2016) suggested that mobile technology and network resources were appropriate to improve self-management and self-awareness in patients with chronic disease. Toukhsati, Driscoll, and Hare (2015) suggested doing a future study, with a social network focus, to enlist and gather collective resources to determine whether e-health interventions might increase self-management in people with chronic illness.

**Pathophysiological Features of Heart Failure**

Internal Medicine defined the etiology of HF as “multifactorial in the patients with HF” (Pfisterer et al., 2009, p. 1). The underlying causes of HF are “ischemic heart disease, valvular heart disease, hypertensive heart disease, and cardiomyopathy” (2009, p.2). Heart failure exacerbation is regularly accompanied by advancing factors, which include anemia, cardiac arrhythmia, infection, renal failure, and the possibility of adverse drug reactions. Thus, HF is difficult to diagnose due to the atypical signs and symptoms.
Definition

Pfisterer and Colleges (2009) stated, “Heart failure with preserved systolic function is common in the adult and elderly because aging has a greater impact on diastolic function. It is important to recognize that elderly patients with heart failure are underrepresented in clinical trials” (p. 384). Numerous unambiguous changes in cardiac function and structure are associated with cardiac pathophysiological and aging that significantly improve HF exacerbation (Manzano et al., 2011).

Pathophysiology and Etiology of Heart Failure

Moreover, the apoptosis of cardiac cells can occur as a normal and controlled part of cardiac function (Wong et al., 2010). This adequate protection from myocardial infraction, ischemia, injury, and myocyte loss, are caused by age (Wong et al., 2010). Changes in the myocytes’ function that is related to stage of HF consist of calcium metabolism impairment that affects cardiac contraction and relaxation (Lakatta & Levy, 2003). Adenosine triphosphate (ATP) utilization is less effective in the cardiac cells of patients with HF. These abnormalities can exacerbate conditions and deteriorate cardiac function (Pandya, Kim, & Smithies, 2006). At the same time, imbalance of extracellular metabolism, with a consequent damaging of myocardial collagen and enlargement of fibrosis, can cause less effective cardiac functions (Chen & Frangogiannis, 2010).

In consequence, a function of age can increase the prevalence of left ventricular hypertrophy and impaired relaxation, cardiac wall thickening, and stiffening of the arterial vascular wall (Jelani & Jugdutt, 2010). As a result, it can further worsen hypertrophy and increase cardiac afterload (Chen & Frangogiannis, 2010). The higher heart rate principally affects the capacity for patients with HF to exercise, due to vascular stiffness (Lakatta & Levy,
In related research, Jelani and Jugdutt (2010) stated that “conditions which further impair ventricular filling, such as AF, may trigger HF decompensation more easily in the aged where cardiac reserve may be further reduced. Conversely, systolic HF is more typical of young patients, probably as a consequence of ischemic heart disease.” During the development of HF, the affected cardiac muscle does not relax appropriately, which inhibits the ventricles from being supplied with blood. This concept is called diastolic heart failure. Another result of a damaged heart is when the heart loses the ability to contract to the full extent to push blood out. This situation is called systolic heart failure. Inefficiencies of cardiac function affect blood flow, decreasing lung congestion or leg edema. Consequently, the visible symptoms include shortness of breath, edema, and a decrease in the QOL for the individual (Ponikowski, 2014).

**The Compensatory Process**

The compensatory process works to maintain cardiac function and compensate for cardiac dysfunction, by such means such as vascular function, neurohormonal responses, and blood volume. The cardiovascular function decreases when the heart loses its capacity to pump efficiently (AHA, 2016.). The neurohormonal response involves constricting blood vessels to sustain normal blood pressures (AHA, 2016). These compensatory processes lead patients with HF to experience a series of worsening symptoms (New York Heart Association (NYHA), 2010).

**Heart Failure Classifications**

The New York Heart Association has classified the symptoms of HF into four categories (Table 2), which helps to define the physical impact on the patients with HF.
Table 2. **NYHA symptom classification system**

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>‘No limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea (shortness of breath).’</td>
</tr>
<tr>
<td>II</td>
<td>‘Slight limitation of physical activity. Comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea (shortness of breath).’</td>
</tr>
<tr>
<td>III</td>
<td>‘Marked limitation of physical activity. Comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea.’</td>
</tr>
<tr>
<td>IV</td>
<td>‘Unable to carry on any physical activity without discomfort. Symptoms of heart failure at rest. If any physical activity is undertaken, discomfort increases.’</td>
</tr>
</tbody>
</table>

Retrieved from: http://www.heart.org/HEARTORG/Conditions/HeartFailure/AboutHeartFailure/Classes-of-Heart-Failure_UCM_306328_Article.jsp#.V3btjLgrLIU

**Role of Patient with HF and Self-management**

According to the NYHA symptom classification system, the patients with HF in functional class I are able to manage their day-to-day activities (NYHA, 2010). Nevertheless, they still require support and care from formal and informal caregivers (Centers for Disease Control and Prevention, 2012). Patients with HF in functional class I and their caregivers can easily complete their tasks and further role obligations. Therefore, mobile apps for patients with HF functional class I are not included in this study. Patients with HF in functional class II experience some physical limitations and require more care from formal and informal caregivers than patients with HF functional class I (NYHA, 2010), but they can manage their day-to-day activities...
activities. Therefore, I included patients in functional class II in the study. I excluded the last two HF functional classes in this study. First, patients with HF in functional class III require more care due to their limitations on physical activities, such as completing daily activities (NYHA, 2010). Second, patients with HF in functional class IV need complete care because they cannot perform day-to-day activities by themselves (American Heart Association, 2016). Patients with HF have less cardiac reserve and lack the ability for the heart to compensate in situations of increased cardiac demands, directly causing physical burdens in patients with HF.

Until now, the factors of cognitive impairment that frequently go along with HF remain unclear. Hajduk, Kiefe, Person, Gore, and Saczynski (2013) stated patients with HF have a high risk of cognitive impairment that can contribute to a decline in adherence to self-management, decreasing their ability to understand information on self-care and treatment. Likewise, monitoring signs and symptoms and using technology can be difficult for patients with HF to understand, memorize, and self-manage due to the complexity of their medical regimen, diet, and fluid restrictions (Hajduk et al., 2013). Failure to self-manage leads patients with HF into worse symptoms, causing readmission or even death in the patients. Therefore, for effective use of the HFAA, I used the Thai 2002 version of the Mini-Mental State Examination to pre-screen the cognitive status of our before the patients were recruited into the study.

**Physical Burden in Patients with Heart Failure**

Heart failure is defined as a chronic illness in which the common symptoms are paroxysmal nocturnal dyspnea, orthopnea, dyspnea, peripheral edema, pulmonary vascular congestion, decreased exercise tolerance, and fatigue (The AHA, 2015). Fatigue, depression, edema, pain, and dyspnea are the most common symptoms of HF. Jessup et al. (2009) stated,
“heart failure is a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood” (p. 5). This health issue creates worsening health outcomes, including dyspnea, tiredness, ankle edema, increased body weight due to fluid overload, dizziness, and re-hospitalization in patients with HF (Jeon et al., 2010).

**Physical Burden**

As Khan (2015) reported, patients with HF experience “decreased wellbeing (94.1%), fatigue (85.9%), shortness of breath (81.2%), anxiety (62.4%) and pain (47.1%). Frequent symptoms reported in follow-up interviews were decreased wellbeing (95.3%), fatigue (88.2%), and shortness of breath (84.7%), anxiety (60.0%) and pain (55.3%)” (p. 1). Managing the intake and output of fluid are important in preventing re-hospitalization of patients with HF. An example of a complication that might cause re-hospitalization is hypervolemia. Hypervolemia can cause edema and poor clinical outcomes in patients with HF, resulting in the need to restrict oral fluids.

Patients with HF commonly need diuretic prescriptions and adjusted fluid and sodium intake, or additional techniques in case of volume overload (Fleming, 2012). Sodium is a factor that affects body fluid volume. Therefore, it is rational to suppose strict control of sodium would be highly valuable (Beich & Yancy, 2008). Overly high sodium intake might lead to diuretic resistance, which can cause re-hospitalization in patients with HF (The AHA, 2010; Fleming, 2012). Thus, interventions, such as intravenous diuretics, adjusted sodium and fluid intake, or additional procedures, are required to control fluid balance or correct fluid overload. However,
Volume depletion can affect renal function due to multiple medical conditions (e.g., fever or diarrhea), overused diuretics, or insufficient fluid intake (Lainscak et al., 2011).

**Burden Management in Patients with Heart Failure**

Present-day research is restricted to focusing on the best fluid management in patients with HF to control fluid overload. Previous studies have suggested that too much sodium consumption could cause diuretic resistance and degeneration, resulting in readmission in patients with progressive HF (Beich & Yancy, 2008). Kollipara and Colleagues (2008) stated that poor knowledge and poor sodium control in patients with HF were associated with hospital readmissions within 90 days. Another randomized pilot study found that patients with HF who followed a restricted sodium intake over 2 grams of sodium and 1.5 liters of fluid would result in increased hospital readmissions. HF can cause body deterioration and even anorexia, leading to a poor prognosis. Appetite is reduced because of liver and gut dysfunction, triggering neurohormonal mechanisms (Lainscak et al., 2011). HF is associated with high resting metabolic rate and catabolic/anabolic imbalances that lead patients with HF to develop cachexia at a rate of around 10% (Lainscak et al., 2011).

Goodlin et al. (2012) stated that more than 50% of patients with HF report having dyspnea, suffering from fatigue, and feeling excessively sleepy. These signs and symptoms could be an effect of non-cardiac or cardiac prescriptions or comorbid disorders. Lum et al. (2016) followed the health status of patients with HF for one year. The physical and emotional results of HF were emotionlessness and grim symptoms, and chest pain. They reported the incidence of non-cardiac pain was as high as 55% – 84% in patients with HF. To develop a positive health
status for patients with HF, interventions must be tailored to the individual that needs care (Lum et al., 2016).

**Health Outcomes of Patients with Heart Failure**

Several studies have examined the outcomes of patients with HF. Moser, Doering, and Chung (2005) explored the incidence of risk factors for re-hospitalization in 202 newly-discharged patients with HF, investigating risk factors of adherence, unhappiness, functional status, QOL, and comorbidity conditions. Outcomes displayed a significantly decreased QOL, significant functional status impairment (70% NYHA III), high levels of hopelessness, and anxiety (69%). A secondary data analysis study identified the similarities and differences of key concepts from 14 qualitative studies. The study found that the ability of patients with HF to understand their disease and their experiences in self-management were associated with coping skills (Lum et al., 2016). Further, the study found that “living with HF was characterized by distressing symptoms, compromised physical functioning, feelings of hopelessness, and role dysfunction. Adjustment required patients to make sense of the illness experience, accept the prognosis, and get on with living with the condition” (Yu, Lee, Kwong, Thompson, & Woo, 2008).

The physical burden of HF is significant and harmful to functions of the body. Hence, to improve the physical function status of those with HF and to decrease hospitalizations, patients with HF need support and the promotion of self-management skills within their daily lives.

**Complex Medication Regimen in Heart Failure**

Patients with HF are educated to control their sodium intake, monitor their body weight, know how to detect threatening symptoms of HF deterioration, and titrate their diuretic dosages.
Patients with HF might feel that these responsibilities are too hard to accomplish without detailed education and assistance with their daily medical regimen (Jeon et al., 2010). Patients with HF take more medications due to worsening conditions and comorbidity of the disease (Nieuwenhuis, Jaarsma, Van Veldhuisen, & Van der Wal, 2012). Jeon, Kraus, Jowsey, and Glasgow (2010) stated that patients with HF often require complex medical regimens and behavior changes according to symptoms and condition progression. Despite improvements in treatment over the last ten years, medical management of HF has become increasingly complicated for patients who suffer from the condition (Nieuwenhuis, Jaarsma, Van Veldhuisen, & Van der Wal, 2012).

**Medical Regimen and Adherence**

After studying complex drug regimens in HF, Jeon, Kraus, Jowsey, and Glasgow (2010) stated that many patients with HF have more experience with, and transformed adherence to, their medical regimen due to changes in healthcare practice and advances in medical regimens. Van der, Wal, and Jaarsma (2008) found high rates of non-adherence to medical advice in patients with HF (p. 203). A study by Butler et al. claimed that, after hospital discharge, 80% of patients received angiotensin-converting enzyme inhibitors and completed the medication within 30 days. A year later, this proportion fell to 60% (Butler et al., 2004). Observational studies have stated that poor medication adherence in patients with HF correlates with worsening health outcomes (Wu et al., 2009). Researchers have found patients with HF can prevent many hospitalizations by following recommendations for use of angiotensin-converting enzyme inhibitors (Chin & Goldman, 1997). These researchers indicated that poor adherence to a medical regimen can cause patients with HF to face hospital readmission.
As Lemon et al. (2010) found, poor adherence to a prescribed medication regimen can cause patients with HF to experience hospital readmission and a low QOL. Ambardekar, Fonarow, Hernandez, Pan, & Yancy (2009) and have evaluated non-compliant patients with HF and found that non-adherence to diet or medications are high frequency causes for readmission to the hospital. Therefore, patients with HF need to maintain consistency and compliance in adhering to their medication regimen, decreasing re-hospitalization and improving symptom management.

Patients with Heart Failure in Thailand

HF is an important worldwide health issue due to its high prevalence of morbidity, death, and costs that are involved in patient care (Toukhsati, Driscoll & Hare, 2015). In East Asia, the burden of HF complications remains severe, as indicated by the rise in HF rates from 1.3% to 6.7% in 2010. Thailand has also experienced significant increases in mortality rates, which have risen from 2% to 9% (Guo, Y., Lip, G. Y., & Banerjee, A., 2013). In Thailand, the number of patients with HF has increased approximately twofold to threefold compare with the last two decades. Heart failure is the cause for 7% of deaths in Thailand (Ministry of Public Health of Thailand, 2012). The Thai Acute Decompensated Heart Failure Registry (ADHERE) reported that Thai patients with HF are younger and have a more severe prognosis than European and American patients. Coronary artery disease (CAD) is a main cause of HF (Laothavorn et al., 2010).

Epistemology

Each year, heart failure disease consumes large amounts of a hospital’s budgetary resources; it costs the Thai government many billions of Baht (Triamchanchoochai, Yamwong,
& Sritara, 2009). Likewise, the Thai ADHERE study reported a 77% re-hospitalization rate among patients with HF who were admitted through the emergency unit, of which, 25% needed a critical care bed (Srisuk, Cameron, Ski, & Thompson, 2014). HF has been identified as a serious chronic illness in Thailand and is becoming a major focus for healthcare services in Thailand (Ministry of Public Health of Thailand, 2008). Due to the complexity of health issues and the significant requirements of clinical care resources in patients with HF, the Thai government and the Ministry of Public Health (MoPH) set national goals to standardize care and decrease hospital readmission rates and cost (Jenghua & Jedsadayanmata, 2011). To lessen the societal burden, it is imperative that patients with HF in Thailand use self-management to prevent hospital readmission, improve health outcomes, and reduce the risk of premature death.

**Self-care Management among Thai Patients with Heart Failure**

Rerkluenrit, Panpakdee, Malathum, Sandelowski and Tanomsup (2013) described three phases of self-care management among Thai patients with HF:

Phase 1: Patients perceive that they have an underlying disease, but lack self-awareness, so they search for support from both traditional therapies and new therapeutic treatments.

Phase 2: Patients turn to and might become dependent on others because their lifestyle changes and their medical regimens become more restrictive.

Phase 3: Patients become familiar with their treatment regimens.

Riegel et al. (2009) conducted a descriptive, comparative study of the differences in the three types of self-care (maintenance, management, and confidence) among patients in the United States, Australia, Mexico, and Thailand. The study found significant differences in self-care among patients in the four countries. Self-care maintenance for Thai patients was lower than
Australian patients. Self-care management for U.S. patients was higher than for Thai patients. Self-care confidence of Thai patients was lower than all three of the other countries. These outcomes show an opportunity to identify methods and new technologies to develop self-care management for patients with HF in Thailand.

Studies have also found that “patients with HF need other resources to help monitor the symptoms of their disease, side effects of medications, to administer their medication, control fluid and sodium levels and to assist with any physical disabilities” (Pressler et al., 2009). Thus, the Minister of Public Health and the Thai healthcare system instituted the necessary programs to develop policies and technologies to promote clinical outcomes, increasing the QOL of patients with HF and decreasing hospital readmission rates.

Mobile Health Apps for Self-management of Patients with Heart Failure

Mobile health apps are alternative tools to augment self-management in chronic disease. They aim to enhance patients’ self-management and encourage changes in individuals’ behavior to improve health outcomes (Man, Nguyen, & Lin, 2014). Many mobile apps have been developed and used globally to enhance day-to-day self-management of diseases for healthcare providers and patients.

The Potential Benefits of Mobile Health Apps

Mobile health apps play a key role in patient education, disease self-management, and remote monitoring of patients (Marcano, Huckvale, Greenfield, Car, & Gunn, 2013). As Mosa, Yoo, and Sheets stated, “self-management and remote monitoring of patients have become viable solutions for management of disease with chronic conditions and are playing an important role” (2012). Mobile phone apps are easily accessible, provide remote solutions for patients with
chronic diseases, and serve as useful assistants in providing topical education and recommendations about medication adherence. They can be key to effective self-management (Park, Howie-Esquivel, & Dracup, 2014).

A study by Man et al. (2014) showed that mobile phone apps provide a positive effect on the management of chronic disease. The apps can be effective for increasing self-management by preventing long-term complications in chronic diseases, such as diabetes and cardiac diseases (Laing et al., 2014). Mobile phone apps help patients who have chronic diseases (heart disease, diabetes, etc.) to monitor diet, daily activities, and medicine for management of their chronic disease. They also improve communication with health professionals and encourage patient compliance (Kim et al., 2015). Man et al. (2014) stated that mobile phone apps can also be powerful devices to educate patients so they can improve their self-management. Likewise, Seto et al. (2012) reported that mobile technology can optimize patients’ medication regimens in a way that significantly strengthens patients’ self-management. Kim et al. (2015) studied 90 users of Diabetes Notepad, a diabetes app that is tailored for diabetes self-management in Korea. The survey study found that this smartphone app could help patients remember to take their medicines. It also answered patient questions and scheduled doctor visits (Kim et al., 2015).

Mobile Apps and Self-management

In terms of self-management, Seto and team reported that the mobile app system delivered appropriate information to assist patients with changing their lifestyle activities. For instance, after high sodium consumption, patients with HF always found that their weight and blood pressure has increased. After weight gain, the patients were authorized to manage and adjust their diuretic medications by themselves. However, they were still often doubtful and
hesitant to take additional medications at home, even though they received previous instruction from their cardiologist to increase their diuretic medications when they needed to (Seto et al., 2012). The mobile app was an ideal solution because it could give individual information and recommendations, giving a patient confidence to make the necessary changes. Therefore, it had a significant positive impact on patient self-management (Seto et al., 2012). Seto et al. (2012) investigated the effects of mobile phone technology on HF management. The mobile phone app was used to assist patients in returning their weight and blood pressure to their normal ranges. The app automatically calculated and immediately offered immediate self-care management advice, such as restricting fluids, taking additional diuretic medication, and reducing salt intake for the next few meals. The study found that self-care management improved due to high medical adherence in patients, particularly for the elderly and patients who were not familiar with mobile phones (Seto et al., 2012). Moreover, mobile phone apps are easy to deliver and offer a low-cost option to large populations.

Cost and Benefits of Mobile Health Apps

Mobile apps are cheaper than alternative options such as cable phones or the Internet (Nundy et al., 2012). Users can easily download an app and send messages to a large number of people (Free et al., 2013). Consequently, mobile phones have wide usage both in developing and developed countries. The considerable use of mobile phone technology in developing countries has improved medical care for chronic diseases, such as heart failure, diabetes, and hypertension (Ben-Zeev et al., 2015). Certainly the number of mobile phone users has grown rapidly, including use among healthcare professionals to enhance self-management and improve clinical outcomes (Mosa, Yoo, & Sheets, 2012).
A study by Pressler et al. (2009) stated that patients with HF require advanced technologies and new resources to observe and monitor their signs and symptoms, manage medications, and restrict fluid and sodium intake, and support physical incapacities. Thus, mobile phone technologies have been used to promote self-management in the day-to-day health routines of patients with HF. They have helped to increase physical function status and decrease hospitalization, especially for patients with HF in rural regions and areas that do not have access to heart failure clinics or hospitals. Mosa, Yoo, and Sheets (2012) stated, “The use of technology in care at home has potential benefits such as improved quality of care. This includes greater focus on the patients’ role in managing their health and increased patient involvement in the care process.” A study of tele-monitoring programs by doctors who specialize in heart failure has indicated that mobile phone technologies decrease re-hospitalization and mortality rates (Free et al. 2013).

Further systematic reviews examined the effects of 25 randomized controlled trials (16 evaluating telephone support, 11 evaluating tele-monitoring, and two evaluating both). The result of the review determined that tele-monitoring reduced mortality by 34%, telephone support reduced it by 12%, and both approaches significantly decreased hospitalization 21% – 23%, improving QOL and decreasing costs (Inglis, Clark, McAlister, Stewart, & Cleland, 2011).

Franklin (2015) stated, “Advances in information and communication technologies, including Internet- and mobile-based communications, social media platforms and self-monitoring health devices, can serve as a means to broadly promote increasing levels of physical activity to improve health outcomes in the HF population” (p. 173). In addition, mobile phone apps provide several benefits for patients with heart failure. For example, patients who have chronic heart failure can realize decreased re-hospitalizations and improved medication
compliance (Inglis, Clark, McAlister, Stewart & Cleland, 2011). A study by Piette et al. (2015) stated, “Mobile health (mHealth) + Care Partner (CP) might also decrease patients’ risk of HF exacerbations related to shortness of breath and sudden weight gain. mHealth+CP may improve quality of life among patients with greater depressive symptoms” (p. 142).

Thus, healthcare systems should encourage more innovative ways to engage patients in social technology support by using new apps and tools to help demonstrate a more active role. As Vuorinen et al. (2014) stated in their study, “home tele-monitoring resources increases patients’ contacts healthcare providers more frequently” (p. 282). Consequently, patients with HF expressed a desire for mobile technology to help them manage their own health (Goldstein et al., 2014).

Therefore, the HFAA can create potential opportunities to enhance the self-management of patients with HF. The purpose of the mobile phone app is to enhance patients’ management of their own health by calculating diuretic prescriptions, controlling fluid consumption, and monitoring possible signs of potential emergency threats. Likewise, the HFAA permits patients with HF to consult their heart clinic team immediately and directly, in case of emergency. Therefore, the HFAA can enhance the engagement of self-management in patients with HF, thus, decreasing readmission rates and increasing functional status for patients.

Unfortunately, research in Thailand has not been thoroughly conducted regarding the in-home use of smart phone apps by patients with HF to provide supportive care. Therefore, this study aimed to examine the effects of the HFAA for enhancing patient self-management, decreasing physical burdens on patients, and hospital readmission rates.
Figure 2. Diagram of study argument.

Heart failure (HF) is the highest cause of hospital readmission and death.

- Self-management in HF
- Physical Burden in HF
- Complex medication regimen in HF
- HF in Thailand

Mobile health applications provide principal benefits for patients with heart failure

- Patients with HF need technology to help monitor their symptoms and side effects of medications, administer medication, and control fluid and sodium levels.

Gap of knowledge

In Thailand, supportive care at home for patients with HF has not been thoroughly conducted in regard to smartphone applications.

Heart Failure Application Aide (HFAA)

Patients with HF increase self-management, decrease physical burden, and improve physical function.

Self-management concept
CHAPTER III: Methods and Procedures

The purpose of this study is to describe the methods used to conduct this study; primarily the study tested differences in hospital readmission rates, physical function, pitting edema, and blood pressure between patients with heart failure (HF) who used the Heart Failure Aid Application (HFAA) and patients with HF who received standard care. I also tested for differences in hospital readmission rates, physical function, pitting edema, and blood pressure before patients used the HFAA and after they used it. The dependent variables were the readmission rates, physical functional status of patients with HF, blood pressure readings, and pitting edema episodes. The independent variable was using the HFAA.

The instruments used in this study included: (1) the screening tool, which was the Mini-Mental State Examination (MMSE) – Thai version 2002, (2) data collection tools: (a) the demographics form, (b) the six-minute walk test (6MWT), (c) the readmission rate, (d) blood pressure, (e) pitting edema, and (f) a body weight scale, and (3) the experimental tools, which was the HFAA.

Design

This dissertation study used a quasi-experimental repeated-measure design, based on two groups in a pretest-posttest design, using self-management in chronic disease as a theoretical framework. The group of Thai patients with HF who received the app were taught self-management skills. This study answered the following question in regard to Thai patients who have HF: Will patients with the HFAA mobile app demonstrate improved self-management skills as evidenced by several physical function variables, including improved 6MWT, lowered blood
pressure and no pitting edema, and reduced hospital readmission rates, compared to patients who do not receive the mobile app?

**Threats to Internal Validity**

**Mortality**

Mortality was a major threat to internal validity in this study because patients who have HF are in the late stage of heart disease, in which complications can cause these patients to drop out of the study. Therefore, an assumed attrition rate by reason of unexpected events, participant withdrawal, and incomplete data was set and added to each group.

**Selection Bias**

Selection bias was another potential threat to internal validity because it is only partially controlled for in the sampling design. Before recruitment of eligible patients, the researcher screened patients based on the documented medical history from the patient’s folder by following inclusion and exclusion criteria. Normally, in Thailand, a patient’s folder contains their information and medical records. After reviewing patient charts, the researcher consulted the patients’ cardiologists to secure permission to approach potential participants for the study. After potential participants were recruited, they were screened based on the exclusion criteria. Upon approval, the researcher contacted the patients face-to-face to inform them of the study and answer their questions, before asking them to participate in the study. After a participant expressed interest in participating in the study, I assessed their cognitive function by using the MMSE – Thai version 2002 for 10 – 15 minutes. The participants, who had normal cognitive function and agreed to be part of the study, were asked to sign the consent form. After participants gave their consent, a simple random assignment was used to assign them through the
free website Research Randomizer (randomizer.org) to either the HFAA or control group. Then, the researcher scheduled a different meeting date and time with the participants in each group to explain the study in detail and answer any additional questions.

**Threats to External Validity**

The external validity of this study was threatened by instrumentation. The 6MWT requires a fair amount of physical equipment, which could contain errors or be below standard. Therefore, calibration was conducted on a regular basis.

**Participant Selection and Assignment**

Convenience sampling was used to select participants. Following confirmation of eligibility, I administered the MMSE – Thai version 2002 to all participants to assess their cognitive function. The MMSE – Thai version 2002 is the standard tool to measure cognitive function, including orientation, registration (immediate memory), short-term memory, and language functioning that could indicate cognitive impairment such as dementia in a person (Thailand National Institute of Health, 2016). The test is useful in assessing capability in decision-making. In interpreting, a score of 0 – 12 out of 30 is considered normal, 13 – 18 indicates mild impairment, 19 – 24 shows moderate impairment, and 25 – 30 indicates severe impairment (Galvin JE & Sadowsky CH. (2012). Participants who had normal cognitive function were asked to sign the consent form.

After I gained a participant’s consent, I used simple random assignment to assign participants equally into both groups. The 120 numbers were assigned participants in each group by a drawing conducted through the Research Randomizer website to randomly assign subjects.
into each group (Geoffrey & Scott, 2016). Half after the top numbers were assigned to the intervention group, and half the lower numbers to the control group.

Research Hypotheses

H1: Thai patients with HF who receive the HFAA will demonstrate improved results for the 6MWT compared to Thai patients with HF who do not receive the mobile app.

H2: Thai patients with HF who receive the HFAA will demonstrate lowered blood pressure compared to Thai patients with HF who do not receive the mobile app.

H3: Fewer Thai patients with HF who receive the HFAA mobile app will have pitting edema compared to Thai patients with HF who do not receive the mobile app.

H4: Thai patients with HF who receive the HFAA will demonstrate lowered hospital readmission rates compared to Thai patients with HF who do not receive the mobile app.

Setting

The setting for the study was a public tertiary hospital, in the North region of Thailand and at the homes of patients with HF. This hospital contained highly specialized medical equipment and expertise in such areas as cardiac surgery, hemodialysis, neurosurgery, burn treatments specialists, and other complicated treatments or procedures. This hospital has six cardiologists and an average of 700 patients with HF per year, making this hospital a good setting for this study.
Sample and Inclusion and Exclusion Criteria

This study required patients diagnosed with HF in New York Heart Association (NYHA) functional class II and who received care in a facility’s heart clinic. They were recruited for this study at the facility hospital heart clinic meeting room.

The inclusion criteria that was used to screen from patients with HF included:

- Age $\geq 18$ years;
- Diagnosis of HF with NYHA function class II indications for a minimum of six months;
- Ability to read and write the Thai language at grade 6;
- Ability to function independently without assistive devices;
- Use of an oral diuretic (patient is permitted to self-titrate made by cardiologist’s prescription);
- Ability to manage care on an outpatient basis; and
- Use of an Android mobile phone.

The exclusion criteria to be used to screen patients with HF included:

- Patients with comorbidities, including acute myocardial infraction (MI) and unstable angina pectoris history, all diagnosed within one month before initiation of the study;
- Patients at the end stage of a chronic diseases, moderate to severe psychological impairments, or both; and
- Need for major immediate surgery.
Sample Size Estimation

G*Power can easily determine the sample size that is needed for repeated measured multivariate analysis of covariance (MANCOVA), repeated measures between factors. The study variables were measured repeatedly over three months (see Table 10). The 6MWT was administered at baseline and at three months to assess a patient’s pulmonary function by measuring the distance they can walk during a 6-minute period (The American Heart Association (AHA), 2016). The maximum time period that is required to complete the 6MWT is 15 minutes. Hospital readmission rates were recorded at three months after participants’ use of the HFAA and for those in the control group. Blood pressure measurements and pitting edema measurements were calculated at four separate times: baseline, and at 30 days, 60 days, and 90 days. The power analysis assumed a baseline measurement and a minimum of four data collection points during the 90-day study period. With a power of 0.95, an alpha level of 0.05, and an effect size of 0.30, the required sample size was calculated at needing 52 for each group. Assuming an attrition rate of 30% due to unexpected events, voluntary withdrawal, and incomplete data, 15 participants were added to each group. A sample size of 67 for each group should be sufficient in repeated measures with multiple data collection points to detect treatment differences.

Procedure

Before I collected the data, I obtained approval from the Committee for the Protection of Human Subjects at the School of Nursing for Catholic University of America, Committee for the Protection of Human Subjects at the Catholic University of America, and the Committee for the Protection of Human Subjects at the selected hospital. The researcher contacted cardiologists and
heart clinic teams by e-mail and met with them in person to request permission to conduct experimentation in the heart clinic. The cardiologists and the heart clinic manager were provided copies of the research proposal, data collection tools, and informed consents (see Appendices A and B).

**Recruitment**

After I received permission from the hospital and approval from Institutional Review Boards (IRB), the researcher advertised the study throughout the facility with fliers. The flier was posted in public places, such as doctors’ offices, hallways, and the cafeteria. After a person expressed interest, the researcher contacted the person, and reviewed the study with them. Then, the researcher met with the potential candidates to ask them to participate in the study. If they agreed, the researcher obtained informed signed consent for participation and answered any questions with the understanding that the patient could withdraw at any time. The recruiting process took place at the heart clinic of the hospital. The participant’s cognitive function was assessed with the MMSE – Thai version 2002 for 10 – 15 minutes before participating in the research study. I asked participants who had normal cognitive function to voluntarily sign the consent form. Due to inclusion and exclusion criteria, all potential patients with HF had to have an NYHA class II medical diagnosed that was made by their cardiologist. After potential participants were recruited, inclusion and exclusion criteria were screened. The researcher emphasized that the study would not interfere with their standard treatments and that all information was kept confidential and anonymous. After gaining the participants’ consent, I used simple random assignment from Research Randomizer to assign participants into each group. To eliminate confounding factors (group contaminate), a separate appointment was made for each
group. The participants in each group participated in the study according to the following procedures (see figure 3).

Figure 3. The study participation procedures in each group.

After recruitment potential participants were recruited, inclusion and exclusion criteria were screened. The researcher gave the research details to the participant through the participant information sheet and invited to participate in this research. Upon a participant’s expressing interest in participation.

Before participating in the research study, the participants’ cognitive function was assessed with the MMSE – Thai version 2002 for 10-20 minutes. The participants who had normal cognitive function were asked to sign the consent form. Simple random assignment was used to assign participants through Research Randomizer to randomly assigned subjects into each group.

Participants (Intervention group)

1. Participants were assessed their physical function with the Six-Minute Walk Test for 15 – 20 minutes for two times (at the beginning and after 90 days).

2. A programmer installed the HFAA on participants’ mobile devices, and the researcher spent 90 minutes demonstrating how to use the application for 90. Participants received a manual for the HFAA to review at home.

3. Participants received a physical examination to measure weight, blood pressure, and swelling dent, and to present a diuretics dose in their mobile phone for a baseline.

4. Participants used the HFAA at home for three months. Daily participants checked their weighed and pitting edema, monitored warning signs of fluid overload, and completed all fields in the HFAA.

5. The HFAA reported participants’ daily diuretic and fluid intake in real time. It offered recommendations for self-management relative to their daily self-management that followed the standard of care for patients with HF at the Chiang Rai hospital. Participants could also directly contact or called the healthcare team via the HFAA.

6. Participants received knowledge of self-care management based on their standard of care.

Participants returned for a physical examination at three month (the project ending).

Participants (Control group)

1. Participants were assessed on their physical function with the 6MWT for 15 minutes, twice during the study: at the beginning and at 90 days.

2. Participants received a physical examination to check for weight, blood pressure, swelling dent, and current diuretics dose in their record form for baseline data.

3. Participants received a general physical examination (weight, blood pressure and pitting edema), at the heart center once a month and at three months.

4. Participants received knowledge of self-care management based on their standard of care.
This study was continuously monitored over three months (see table 3.) For participants who discontinued use of the HFAA, had worrisome symptoms, or received warning alerts from the HFAA, contact was initiated by the healthcare team to inquire about problems and offer advice. The subject participants were also informed that after completing the meetings and training, they would receive 150 Baht (about US$5). Each participant who returned to complete the 6MWT and blood pressure and pitting edema measurements at three months received 150 Baht (about US$5). Additionally, participants of the intervention group received a digital weight scale, a digital blood pressure monitor, and HFAA installed on their mobile phone.

Table 3.

*The Measurement Timeline.*

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Baseline</th>
<th>30th day</th>
<th>60th day</th>
<th>90th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>6MWT</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Pitting edema</td>
<td>/</td>
<td>/</td>
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<td>/</td>
</tr>
<tr>
<td>Readmission rate</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

**Instrumentation**

Eight instruments were used in this study. These instruments were (a) the demographics form, (b) MMSE – Thai version 2002 (c) the 6MWT, (d) readmission rate, (e) blood pressure, (f) pitting edema, (g) body weight scale, and (h) the HFAA.

**Demographics Form**

The demographics form (see Appendix C) was a self-administered questionnaire developed by the researcher to elicit demographic and personal medications data. The form had
eight items, including gender, race, marital status, education level, occupational status, household income, cause of heart failure, and prescription medications.

**Test validity**

In this study, I used the content validity index (CVI) for the demographics form. Three qualified experts (a cardiologist, a cardiac nursing professor, and a cardiac nurse practitioner) evaluated and modified the questions. A CVI of .80 or higher is considered “acceptable” (Burn & Grove, 2014).

**Mini-Mental State Examination – Thai version 2002**

For inclusion criteria, The MMSE – Thai version 2002, which is a national test for the Thai population, was employed in this study to pre-screen the subjects’ cognitive function before recruiting them in the study. The tool has generally been recommended for the screening of cognitive function (Thailand National Institute of Health, 2016). Additionally, the MMSE – Thai version 2002 is publicly permitted without any cost. It consists of orientation, registration (immediate memory), short-term memory, and language functioning (see Appendix D) (Thailand National Institute of Health, 2016).

The MMSE – Thai version 2002 is a self-administered questionnaire and is beneficial in evaluating competency in decision-making. The MMSE was translated directly into the Thai language (MMSE-Thai, 2002) and was validated for people age 60 years and older. Its sensitivity varies in the range 71% – 92% and its specificity ranges 56% – 96%, depending on the cutoff point that is used for an abnormal test (Limpawattana, Tiamkao, Sawanyawisuth, & Thinkhamrop, 2012).
The MMSE – Thai version 2002 takes 10 – 20 minutes to be administered to assess cognitive functioning in adults, and scoring takes just 5 minutes. In interpreting, a score of 0 – 12 out of 30 considered normal, 13 – 18 indicates mild impairment, 19 – 24 shows moderate impairment, and 25 – 30 indicates severe impairment (Limpawattana, Tiamkao, Sawanyawisuth, & Thinkhamrop, 2012).

**Reliability and validity**

In the study by Graipaspong, Thaipisuttikul, & Vallipakorn (2016), the subjects with a cut-off score of 14 from 30 were classified as illiterate (sensitivity 35.4%, specificity 81.1%, positive predictive value 69.0%, negative predictive value 51.3%); subjects with the score of 17 from 30 is classified as primary school graduate (sensitivity 56.6%, specificity 93.8%, positive predictive value 88.9%, negative predictive value 71.0%); subjects with the score of 22 from 30 is labelled as those who graduated higher than primary school (sensitivity 92.0%, specificity 92.6%, positive predictive value 91.2%, negative predictive value 93.3%) (Ministry of Public Health Thailand. (2012)). I used the content validity index (CVI) for the MMSE -Thai 2002. Three qualified experts (a psychiatrist, a psychiatric nursing professor, and a psychiatric nurse practitioner) evaluated them. A CVI of .80 or higher is considered “acceptable” (Burn & Grove, 2014).

**Limitation**

Even though the MMSE-Thai 2002 is the most universally used screening instrument for any condition or status and translated into different languages, the limitations of the test are inconsistency in sensitivity to educational levels (Limpawattana, Tiamkao, Sawanyawisuth, & Thinkhamrop, 2012).
Six-minute Walk Test

I used the 6MWT in this study to measure the differences in participants’ physical burden. I administered the 6MWT at baseline and again at three months, to measure the difference in physical function of patients with HF after using the HFAA. In 1963, Balke developed the 6MWT to assess functional capacity. It is a simple, objective and easily reproducible measurement of functional capacity (Du, Newton, Salamonson, Carriero-Kohlman, & Davidson, 2009).

Administration and scoring

The test requires patients with HF to walk as far as they can within a six-minute time period. A low score (distances of < 300 meters) indicates lower functional capacity (American Thoracic Society, 2002). The technician who administers the test should be trained. Therefore, one advanced practice nurse (APN) at the facility hospital was designated to test 6MWT in patients with HF for this study. The maximum time period required to complete the test is 15 minutes.

Equipment required

The equipment required for the 6MWT is a walking track, a cone to mark the boundaries of the walking course, a stopwatch, a stethoscope, a pulse oximeter, vital signs equipment, and a chair for patients to use if they need to rest during the test.

Test-retest reliability

Test-retest reliability has been reported as high with an intraclass correlation coefficient (ICC) of 0.90 at the baseline, 0.88 at 18 weeks and 0.91 at 43 weeks in a cohort of patients with HF (Demers, McKelvie, Nagassa, & Yusuf, 2001). Cataneo, Kobavasi, Carvalho, Paccanaro, & Cataneo (2010) reported moderate to high “relationships (r= 0.56 to r= 0.88) between the 6MWT
and peak exercise oxygen uptake (VO2 peak) obtained by maximal exercise testing in persons with HF; accuracy was 80% and sensitivity and specificity >90% compared to maximal oxygen uptake in 51 Patients with HF” (p. 194). Enright (2003) reported the strengths of the 6MWT are that it is safer, easier to administer, and better reflects the activities of daily living than other walk tests” (p. 784).

Accordingly, Vuckovic & Fink (2012) stated the 6MWT is harmless even in severe patients with HF (NYHA class IV) and has been used to monitor HF progression, consider management or treatment effects, and forecast readmission and mortality. In Thailand, Suwanachiyy and team (2010) reported 6MWT was a suitable assessment for pre-treatment and post-treatment evaluations, quantifying functional capacity and forecasting morbidity and mortality in patients with HF. Because the 6MWT is available in multiple languages, including Thai, it does not create any language barriers and cultural biases.

Limitations

The 6MWT is most commonly used to evaluate the functional status of patients with HF because it is easy to perform and interpret without any reading or cultural biases (American Thoracic Society, 2002). However, it has some limitations because it requires a large amount of equipment, and experienced technicians are needed to administer the test.

Internal validity can become an issue with maturation due to the study’s two measurements: the first one at the baseline and the second one after three months. After the three-month period, participants could gain more experience in doing the test, reducing the validity of the test. Moreover, severe complications among patients with HF can also threaten the validity of the test either by patients dropping out of the program or even dying.
Readmission Rate

The Ministry of Public Health (MOPH, 2012) defined hospital readmission as readmission within 90 days after initial discharge. This study recorded the facility hospital readmission rate of participants at three months after they used the HFAA through a computer record system (ICD-9) that was controlled by the Minister of Public Health.

Blood Pressure

Daily blood pressure (BP) was recorded on the mobile app. using the digital blood pressure monitor; participants of the intervention group took their blood pressure each morning and transmitted their reading via the mobile app. All intervention participants were trained in using the digital blood pressure machine and were required to demonstrate its proper use to the researcher during the initial training. In addition, throughout the first three months, the researcher visited participants to conduct reliability checks, ensuring that participants continued to use the equipment consistently and correctly via the HFAA check and alert system every day. When a participant failed to complete the submission through HFAA or had life-threatening symptoms, the HFAA sent an alert directly to the researcher’s mobile device. Then the healthcare team directed and immediately called the participant to offer help. The participants of the control group need to get a general physical examination, including blood pressure check, at the heart center once a month, during the three months.

Test reliability

To ensure accuracy of the digital blood pressure monitor readings and their reliability, the researcher completed quality checks and calibration adjustments with personnel at the
Science and Technology Institute. Digital blood pressure monitors operated with a continuous electric charge to prevent possible data error from a low battery.

Administration

I used the AHA blood pressure categories to report participant blood pressures. All patients were trained on how to maintain the equipment and were given a contact number of the facility to report any issues or concerns. For scoring, blood pressure measurements were calculated at three separate times: baseline, 30th day, 60th day, and 90th day. For the 30-day measurement, I averaged the blood pressures from day 1 to 30. For the 60-day measurement, I averaged the blood pressures from days 31 to 60. For the 90-day measurement, I averaged the blood pressures from days 61 to 90, calculating systolic and diastolic separately.

Finally, the researcher documented all hypertensive medications that the patient was taking throughout the duration of the study. Documentation included the name of the medication, dosage, frequency of dose, route of administration, missed doses and any additions, deletions, or changes in medication regimen.

Pitting Edema

Pitting edema is observable “swelling of body tissues due to fluid accumulation that may be demonstrated by applying pressure to the swollen area (such as by depressing the skin with a finger). If the pressing causes an indentation that persists for some time after the release of the pressure, the edema is referred to as pitting edema” (Medicinenet.com, 2016, p.1).

Administration

Daily measurements of the patient’s pitting edema scores were recorded via the mobile application. The patients measured their pitting edema each morning and entered the readings on
the mobile application. All participants were trained how to evaluate and measure for pitting edema and were required to demonstrate these skills to the researcher. In addition, throughout the first three months, the researcher visited patients to conduct reliability checks, ensuring that patients continued to measure pitting edema consistently and correctly. Participants in the control group needed to get a general physical examination for pitting edema at the heart center once a month, during the three months.

**Scoring**

The pitting edema scores range 0 – 4. In general, pitting edema grading was determined by the deepness and rebounded duration time of the skin density (AHA, 2016). Pitting edema has the following grading and definitions:

1. 0 = No skin density;
2. 1+ = 2 mm deep depression or less; rebounds rapidly (mild);
3. 2+ = 2-4 mm deep depression, rebounds in 10 – 25 seconds (moderate);
4. 3+ = 4-6 mm deep depression, rebounds over 1 minute (moderately severe); and
5. 4+ = 6-8 mm deep depression, rebounds in 2 – 5 minutes (severe) (AHA, 2016).

For scoring, pitting edema measurements were calculated for four separate times: baseline, 30 days, 60 days, and 90 days. For the 30-day measurement, I average the pitting edema measurements for days 1 – 30. For the 60-day measurement, I averaged the pitting edema measurements for days 31 – 59. And, for the 90-day measurement, I averaged the pitting edema measurements for days 61 – 90.

Finally, the researcher documented all diuretic medications that the patients took during the study. This medication documentation included the name of the medication, the dosage,
frequency of the dose, route of administration, missed doses, and any additions, deletions, or changes in medication regimen.

**Heart Failure Aid Application**

HFAA is a mobile app that was developed to enhance self-management in patients with HF in Thailand. This mobile app was specifically developed for Android smartphones (the operating system created by Google and the top mobile operating system in 2016 (Stat Counter Global Stat, 2016)). The HFAA was created and designed by software engineers in collaboration with the researcher to enhance self-management in patients with HF. The design goal for the enhanced self-management app was to simplify self-care management so that users could use it on a daily basis. This private mobile app was devised by the researcher and was available free of charge and only for participants in the study.

**Function of the HFAA**

An HFAA provided adjustment of an individual’s diuretic and fluid intake, monitoring of warning signs (e.g., pitting edema, respiratory rate, sleeping problems, and need for additional pillows). It also included additional features such as HF education materials and emergency contact. To calculate values in the HFAA, the software used a diuretic and fluid intake standard that was formulated by the Thailand Heart Association Continuing Medical Implementation.

**Indicating functions**

To evaluate and report an individual’s daily plan, the HFAA software used three colors for HF self-management (AHA, 2016) (see Appendix H). Green letters indicated that the symptoms were controlled, and the participant could continue taking the medication as ordered. The green letters also indicated that the patient could follow healthy eating habits and keep
regular appointments. Yellow letters indicated the participant’s symptoms might require a medication adjustment, in which case the participant was provided daily diuretic dose adjustments. Red letters indicated that the participant needed to contact the healthcare team immediately and see his or her doctor for medical attention.

Supporting functions

The patient could also directly contact or call the healthcare team via this app. Furthermore, the HFAA alerted the researcher regarding high-risk patients, signified by red letters, for immediate contact and assistance. The Self-Care Management Program on Quality of Life in Patients with Heart Failure by Tangvijitskule (2005), which was developed based on the self-management theory, was also entered into HFAA mobile app for HF education material. This resource provides patients with important information, such as the definition, cause, and factors of HF, and the ability to conduct self-weighing, self-administered pitting edema tests, and self-tested blood pressure measurements. The CVI of the Self-Care Management Program on Quality of Life in Patients with Heart Failure is 0.98 (Tangvijitskule, 2005). This education information was available within the HFAA if the user chose to view it.

Supporting Self-Care Management by HFAA

HFAA incorporates the Tangvijitskule’s guidance (2005) and mobile technology approach to enhance self-management in patients with HF. Self-monitoring, consisting of recording body weight and measuring of pitting edema, blood pressure, and other symptoms, is strongly associated with the improvement of physical function and a decrease in readmission rates among patients with HF (Laing et al., 2014). This app can help patients with HF to accurately adjust their daily diuretic and fluid intake, which is a crucial part of HF self-management (Ritklar, Wattana, & Kitipawong, 2012). Carter, Burley, Nykjaer, and Cade (2013)
stated that adherence to diet self-monitoring is higher among patients who use smartphone apps compared to patients who use a daily paper log. The social networking feature of the HFAA offers benefits of social support for self-management.

**User Requirements**

All participants measured and entered their blood pressure and weight, and observed their symptoms on the HFAA every day. An alert system was a desirable feature of the HFAA, since regularly interacting with the HFAA is a crucial requirement to improve self-care management in patients with HF, and adherence to medications is an essential part of heart failure self-care. Ruppar, Delgado, and Temple (2015) found that medication adherence and patient behavior changes are far more effective factors in health improvement than support from healthcare providers.

**User Interactivity**

An appointment was set separately for members of the intervention group to install the HFAA by the programmer and training and demonstration by the researcher. These participants received a phone call from the researcher one week after enrollment to assist with any technical problems with the app. Participants entered their current weight and diuretic dose as a baseline on their mobile phones for day-to-day diuretic and fluid intake adjustment and self-management (see Figure 4). For daily use, participants entered the HFAA at a simple main menu (see Figure 5), and normally selected Start to go to diuretic adjustment mode. Then, the users entered daily information on the app. While participants were actively accessing the HFAA, they could go back to revise information before they tapped Submit to finish. They then received daily diuretic doses, fluid intake, and individual daily plans or recommendations in one of three colors as
previously described. They also saw recommendations on the reporting screen as the same
diuretic and fluid reporting time (see Figure 4).

Participants could click Daily Plan in the HF education box feature on the app to gain a
better understanding about what might be driving and maintaining their health (self-
management). The HFAA also reported the participants’ daily diuretic and fluid intake in real
time and offered recommendations for self-management relative to their daily body weight,
signs, and symptoms. The responses on the HFAA were automatically transferred to the database
where only the researcher and team could access the information. If a patient failed to enter data
daily on the HFAA, due to an Internet connection problem or a personal restriction, the HFAA
alerted the healthcare team and researcher devices. The researchers solved this problem by
having the healthcare team visit the patient’s homes to reinstall the app and retrain the patients
how to use the Internet browser of the mobile phone.

Data Security

After the HFAA was downloaded, the data were transferred automatically on a daily
basis to a data server (see Figure 7). All research data were transferred automatically to a local
private data server that the researcher owned. It was under the researcher’s control in a locked
file cabinet (password protected) for one year after the dissertation was completed. Heart Failure
Mobile Phone Aid Application (HFAA) log in and data access were also password protected and
accessible only to researcher, cardiologist, and nurse practitioner. The researcher and clinical
professionals in the HF clinic could examine the data by a link to his or her records via the
researcher and clinical professional’s username and password. After completing the analysis, the
researcher removed all information regarding the participants’ information.
Figure 4. Screen captures showing the baseline body weight and diuretic doses.
Table 1: Clinical indicators of heart failure in atrial fibrillation (HFAA).

<table>
<thead>
<tr>
<th>Clinical Indicator</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitting edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed additional pillows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Startled awake several times a night</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory rates or blood pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of caught</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Main menu for HFAA coughs.
The patient’s daily fluid intake

The patient’s daily diuretic doses

The patient’s daily recommendations and education based on yellow, green, and red colors and contact telephone number link

Figure 6. Information screen for users.

User

Processing

Loading

Processing

Input information and sending

Daily diuretic doses and recommendations

Transfer data to server

Finish

Figure 7. Elements of a HFAA.
Test validity

The HFAA used random testing to test for reliability. This type of testing attempted to crash or hang the app by providing false, non-logical input. The input could be keyboard-forced into the application. Random destruction testing was used to test important error paths and expose bugs in the HFAA software. This test could be highly automated because it did not apply to how the underlying application was supposed to work (Microsoft, 2016). Also, this study used random input testing that was conducted and revised based on the recommendation of three qualified experts: a cardiologist, a cardiac nursing professor, and a cardiac nurse practitioner. A CVI of .80 or higher was considered “acceptable” (Burn, Grove, & Gray, 2014).

Ethical Considerations

To protect the participants who volunteered in the research, this study was reviewed by the School of Nursing and the Committee for the Protection of Human subjects at the Catholic University of America.

Privacy, Security, and Data Ownership

Subjects were assured that intervention was anonymous, confidential, and was accessible only to the research team. The subjects were not identified on any of the information gained, and no intervention manipulation took place. All data were coded numerically and did not match the participants’ names. The participants were assured that their participation was voluntary. The HFAA emphasized self-management in patients with HF accessible only to participants of this study (not available to public). This study was strictly based on a voluntary basis. It did not affect standard HF treatment provided by the facility hospital.
Race or ethnicity questions were for demographic reason only, not to identify or discriminate against the subjects. Copies of all instruments and protocols that were used were given to the participants.

**Obtaining Informed Consent**

Before the consent form for this study was signed, all details of the study were explained to potential participants and all their questions were answered (see Appendices A and B). The informed consent contained a description of the study’s aims, method, time requirements, possible risks, benefits, and how risks were minimized. In addition, they were informed of their rights to anonymity, confidentiality, and withdrawal from the study at any time without penalty or effect on treatment. A copy of the participants’ signed consent form was given to them.

**Storing and Sharing Mobile Phone Data**

All data were transferred automatically on a daily basis to a data server and kept under the researcher’s control in a locked file cabinet (password protected) for one year after the dissertation was completed. All identifiers were destroyed after that.

Participants were informed that the intervention was confidential and anonymous. An HFAA user login and data access were also password protected and available only to the study participants, researcher, and heart clinic team.
Participants with HF class II (NYHA), inclusion and exclusion criteria. Provided the study information and invited to participate in this research.

Cognitive function assessment with the MMSE – Thai version 2002.

Participants who had normal cognitive function were asked to sign the consent form.

Simple random assignment through Research Randomizer (n=134)

Allocation

Intervention group (n=67)
  Daily use HFAA
  (See Figure 5)

Monitor by researcher

Complete 12 weeks

Control group (n=67)
  Usual care
  (Receive text massage)

Implementation

Follow-up

Data analysis

Analyzed

Analyzed
Time Frame

This study was continuously monitored over three months. After IRB approval, the researcher recruited and screened candidates, obtained consent forms, and enrolled each participant. The participants then immediately began the study.

Plan for Data Management and Analysis

Initial data analysis consisted of descriptive and inferential statistics using the IBM® Statistical Package for the Social Studies (SPSS) 21.0. This study was based on a conceptual framework that proposed that the HFAA enhanced six skills of self-management in HF that influenced the outcomes. The dependent variables were the physical function capacity, readmission in 90 days, pitting edema, and blood pressure of patients with HF.

1. Descriptive statistics were used to analyze the demographic data (e.g., age, gender, history of HF, education, and income) and the descriptive characteristics for the major variables within the intervention and control groups: 6MWT, blood pressure and pitting edema, and hospital readmission at 90 days.

2. Bivariate analysis was conducted to examine the relationships between the pre-intervention variables (blood pressure and pitting edema), the covariate and the post-intervention variables (post-intervention readmission rates, 6MWT, blood pressure, and pitting edema).

3. Repeated measures MANCOVA was used to detect differences between the mean values across three timeframes (30, 60, and 90 days) for measurement of blood pressure and pitting edema, a 90-day post-intervention 6MWT and hospital readmission rate and covariate. According to research questions, alpha was set at .05 to assess significance.
Summary

This chapter described the methodology of the study. It included the following elements:
(a) study design, (b) internal and external validity, (c) hypotheses, (d) setting, (e) sample, (f) procedure, (g) instrumentation, (h) protection of human subjects, and (i) data analysis plan.
CHAPTER IV: DATA ANALYSIS AND RESULTS

Introduction

The purpose of this study was to test whether there were differences in readmission rate, physical function, pitting edema, and blood pressure between patients with heart failure (HF) who used the Heart Failure Aide Application (HFAA) and patients with HF who received the usual treatment. The findings revealed that there were differences between the two groups in all these measurements. The dependent variables included the readmission rates, physical functional status of patients with HF, blood pressure readings, and episodes of pitting edema. The HFAA was the independent variable. To provide evidence for the feasibility of using the HFAA to measure self-improved physical function and reduce hospital admissions related to HF, four hypotheses were tested:

H1: Thai patients with HF who use the HFAA will demonstrate improvements in the six-minute walk test (6MWT) compared to those who do not use the mobile app.

H2: Thai patients with HF who use the HFAA will demonstrate lower blood pressure compared to those who do not use the mobile app.

H3: Fewer Thai patients with HF who use the HFAA will experience episodes of pitting edema compared to those who do not use the mobile app.

H4: Thai patients with HF who use the HFAA will demonstrate lower hospital readmission rates compared to those who do not use the mobile app.

The current chapter presents (a) the data collection procedures, (b) a description of the sample, (c) an evaluation of the instruments, (d) a report on the hypothesis testing and, (e) a summary of the findings.
Data Collection Procedures

The present study was conducted over three consecutive months. After performing an eligibility screening at the Heart Clinic and collecting informed consent from the eligible patients, a total of 120 subjects were assessed via the Mini Mental-State Examination (MMSE; 2002 Thai version) and found to have normal cognitive function. Information regarding the subjects’ demographics were collected from their written answers to the nine-item Background Data Form (see Appendix C). This form provided information about the following characteristics: (a) gender, (b) age, (c) race, (d) marital status, (e) education level, (f) occupation, (g) total household income from the previous year, (h) etiology of HF, and (i) prescription medications.

The study sample size was 120. All subjects were randomly assigned to either the intervention group (50%, N=60) or the control group (50%, N=60) via the website “Randomizer.com.” Both groups received the usual treatment for HF. The researcher scheduled separate meeting dates with the subjects of each group to describe the details of the study and answer any additional questions. The baseline, 30-day, 60-day, and 90-day measurements, including blood pressure, 6MWT scores, pitting edema, and hospital readmission rate, were taken from all 120 subjects.

Evaluation of the Instruments

The following eight instruments were used in this study: (a) the Background Data Form, (b) the Mini Mental-State Examination (MMSE; 2002 Thai version), (c) the Six-Minute Walk Test (6MWT), (d) the hospital readmission rate records, (e) the blood pressure monitors and the body weight scales, (g) the pitting edema (individual evaluation) and (h) the Heart Failure Aide Application (HFAA) for mobile phones.
Background Data Form

The nine-item Background Data Form, described earlier in this chapter, was used to define the sample and collect information about the subjects’ individual demographics (Appendix C).

Mini Mental-State Examination

The 2002 Thai version of the MMSE was used to pre-screen the subjects’ cognitive impairment after consent and before they were recruited to participate in the study. The test reliability of the 2002 MMSE (Thai version) was $\alpha=0.935$. (Appendix D).

Six-Minute Walk Test

Permission to use the 6MWT was granted on November 28, 2016 by Dr. Corn, Director of Documents and Patient Education of the American Thoracic Society. The advanced practice nurses (APNs) at the study site were trained to perform the 6MWT with the subjects of the present study. The interrater reliability of the 6MWT was $\kappa=1$. (Appendix E).

Hospital Readmission Rate Records

The hospital readmission rates were recorded using a computer system (ICD-9) at day 90 after using the HFAA that was under the control of Thailand’s ministry of public health (MoPH).

Blood Pressure Monitors and Body Weight Scales

Quality checks and calibration procedures were completed on the digital blood pressure monitors and body weight scales by personnel of the Science and Technology Institute.

Pitting Edema Evaluation

All subjects were trained and did a return demonstration of self-examination for pitting edema with the researcher. The interrater reliability of the evaluation tool was $\kappa=1$. 
Heart Failure Aide Application

The HFAA was tested by three qualified experts: a cardiologist, a professor of cardiac nursing, and a cardiac nurse practitioner. The validity of a Heart Failure Aide Application (HFAA): the scale-level content validity index, using the averaging method (I-CVI/Ave), was .95. The average index of the items evaluated across all three experts was .95 (Burn, Grove, & Gray, 2014).

Description of the Sample

The sample in this study included a purposive sample of patients with New York Heart Association Functional Classification (NYHA) functional class-II HF, as diagnosed by a cardiologist, and who were receiving care at the heart clinic of a public hospital (over 700 beds) located in the northern region of Thailand. The subjects were recruited according to a set of inclusion–exclusion criteria, as described in Chapter 3.

All adult age ranges were represented in the sample. The subjects (3.3%) were between the ages of 21–30 years, followed by 8% between 31–40 years, 12.5% between 41–50 years, 29.2% between 51–60 years, 35% between 61–70 years, 12.5% between 71–80 years, and 0.8% between 81–90 years. The sample was comprised of 34 females (28.3 %) and 86 males (71.7%). Their religious beliefs included Buddhism (97.5%), Christianity (1.7%), and Islam (0.8%). While there was a larger number of married subjects (73.3%), others were widowed (0.8%), divorced (15.0%), separated (6.7%), or had never been married (4.2%). Most of the subjects (58.4 %) had completed the sixth grade, 22.5% had graduated from high school, 10.0% held a bachelor’s degree, 8.3% finished a master’s degree, and 0.8% had a doctoral degree. Regarding occupation, 31.7% of the subjects were unemployed, 20.0% owned a business, 16.7% were employed in private companies, 15.8% worked in agriculture, 8.3% held a public office (i.e., governor), 5.8%
were retired, and 1.7% were employed in other public positions, such as police officers and nurses. Concerning household income for the previous year, 35% reported incomes lower than 2,000 Baht and 31.6% made 5,001–10,000 Baht, while the same number of subjects made 2,001–5,000 and over 10,000 Baht (16.7%). The demographic findings were presented in Table 4.

Table 4. 
**Subject Demographics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Values</th>
<th>Frequency a</th>
<th>Percentage b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age c</td>
<td>21–30</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>31–40</td>
<td>8</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>41–50</td>
<td>15</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>51–60</td>
<td>35</td>
<td>29.2</td>
</tr>
<tr>
<td></td>
<td>61–70</td>
<td>42</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>71–80</td>
<td>15</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>81–90</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>86</td>
<td>71.7</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>34</td>
<td>28.3</td>
</tr>
<tr>
<td>Religion</td>
<td>Buddhism</td>
<td>117</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td>Islam</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Christianity</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Marital status</td>
<td>Never married</td>
<td>5</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>88</td>
<td>73.3</td>
</tr>
<tr>
<td></td>
<td>Separated</td>
<td>8</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>Divorced</td>
<td>18</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Widowed</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Education c</td>
<td>Less than high school</td>
<td>69</td>
<td>58.4</td>
</tr>
<tr>
<td></td>
<td>High school graduate</td>
<td>27</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s degree</td>
<td>12</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Master’s degree</td>
<td>10</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Ph.D.</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Occupation</td>
<td>Unemployed</td>
<td>38</td>
<td>31.7</td>
</tr>
<tr>
<td></td>
<td>Business owner</td>
<td>24</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Private employee</td>
<td>20</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>Governor</td>
<td>10</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>19</td>
<td>15.8</td>
</tr>
<tr>
<td></td>
<td>Retired</td>
<td>7</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>2</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Regarding etiology, the subjects reported being diagnosed with valvular heart disease within the last six months (32.5%), ischemic cardiomyopathy (IHD; 61.7%), and other conditions (5.8%), such as myocarditis, congenital heart defects, heart arrhythmias, and chronic diseases (e.g., diabetes and hyperthyroidism). The subjects’ etiologies of HF were displayed in Table 5.

Table 5.
subjects’ Etiologies of HF

<table>
<thead>
<tr>
<th>Variables</th>
<th>Values</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etiology</td>
<td>Valvular disease</td>
<td>39</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>IHD</td>
<td>74</td>
<td>61.7</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Note. aN=120; b All variables=100%.

All the subjects had been prescribed diuretic medication to manage HF, while 75.8% had been prescribed an angiotensin-converting-enzyme inhibitor (ACE inhibitors) (i.e., enalapril [52.5%] and losartan [23.3%]), 91.7% had been prescribed beta blockers (i.e., carvedilol [90.8%] and atenolol [0.8%]), 61.7% had been prescribed spironolactone, and 9.2% had been prescribed digoxin. Other prescription medications included allopurinol (0.8%), acetylsalicylic acid (ASA) (18.3%), folic acid (0.8%), warfarin (26.7%), simvastatin (22.5%), and hydralazine (4.2%). The subjects’ prescription medications were shown in Table 6.

Table 6.

Subjects’ Prescription Medications

<table>
<thead>
<tr>
<th>Variables</th>
<th>Prescriptions</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE inhibitor</td>
<td>None</td>
<td>29</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>Enalapril</td>
<td>63</td>
<td>52.5</td>
</tr>
<tr>
<td></td>
<td>Losartan</td>
<td>28</td>
<td>23.3</td>
</tr>
</tbody>
</table>
Comparison of the intervention group research results and the control group

Comparison between the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores at day 0 and day 90 of control group

A paired sample t-test was conducted to compare the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores at Day 0 and Day 90. The results for the control group were presented in Table 7.

Table 7.

Mean Differences in Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores at Day 0 and Day 90 (Control Group; N=60)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Day 0</th>
<th>Day 90</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LL</td>
<td>UL</td>
<td>LL</td>
<td>UL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP</td>
<td>121.05</td>
<td>20.07</td>
<td>115.65</td>
<td>18.41</td>
<td>2.23</td>
<td>.03*</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>68.67</td>
<td>12.66</td>
<td>71.17</td>
<td>14.71</td>
<td>-1.24</td>
<td>.22</td>
</tr>
<tr>
<td>Pitting edema</td>
<td>2.23</td>
<td>7.61</td>
<td>1.13</td>
<td>1.03</td>
<td>1.10</td>
<td>.28</td>
</tr>
<tr>
<td>6MWT</td>
<td>324.43</td>
<td>107.87</td>
<td>312.60</td>
<td>103.80</td>
<td>1.24</td>
<td>.22</td>
</tr>
</tbody>
</table>

Note. * p<0.05; CI=confidence interval; LL=lower limit; UL=upper limit. 

Note. a N=120; b All variables=100%.
There was a significant difference in systolic blood pressure measured on Day 0 (M=121.05; SD=20.07) versus Day 90 (M=115.65; SD=18.41); t(59)=2.23; p=0.03. These results showed that systolic blood pressure had decreased in the control group.

There was no significant difference in diastolic blood pressure measured on Day 0 (M=68.67; SD=12.66) versus Day 90 (M=71.17; SD=14.71); t(59)=-1.24; p=0.22. These results indicated that diastolic blood pressure did not change in the control group.

There was no significant difference in pitting edema recorded on Day 0 (M=2.23; SD=7.62) versus Day 90 (M=1.13; SD=1.03); t(59)=1.09; p=0.28. These results demonstrated that there was no change in pitting edema among the subjects of the control group.

There was no significant difference in the subjects’ scores for the 6MWT on Day 0 (M=324.43; SD=107.87) versus Day 90 (M=312.60; SD=103.80); t(59)=1.24; p=0.22. These results showed that the 6MWT had decreased in the control group.

In summary, for the control group systolic blood pressure had decreased in subjects who received standard care, while diastolic blood pressure, pitting edema, and 6MWT scores had not changed between Day 0 and Day 90.

Comparison between the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, and 6mwt scores at day 0 and day 90 of intervention group

The mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores at Day 0 and Day 90 for the intervention group were presented in Table 8.
Table 8.

Mean Differences in Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores at Day 0 and Day 90 (Intervention Group; N=60)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Day 0</th>
<th>Day 90</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M  SD</td>
<td>M  SD</td>
<td></td>
<td></td>
<td></td>
<td>LL  UL</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>114.32</td>
<td>19.02</td>
<td>115.10</td>
<td>12.41</td>
<td>-.38</td>
<td>59  .71</td>
</tr>
<tr>
<td></td>
<td>-4.90</td>
<td>3.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>68.53</td>
<td>12.77</td>
<td>68.70</td>
<td>11.17</td>
<td>-.09</td>
<td>59  .91</td>
</tr>
<tr>
<td></td>
<td>-3.89</td>
<td>3.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ** p<0.01; * p<0.05; CI=confidence interval; LL=lower limit; UL=upper limit.

There was no significant difference in systolic blood pressure measured on Day 0 (M=114.32; SD=19.02) versus Day 90 (M=115.10; SD=12.41); t(59)=-0.38; p=0.71. These results show that systolic blood pressure had not changed in the intervention group.

There was no significant difference in diastolic blood pressure measured on Day 0 (M=68.53; SD=12.77) versus Day 90 (M=68.70; SD=11.17); t (59) =-0.09; p=0.93. These results indicated that diastolic blood pressure had not changed in the intervention group.

There was a significant difference in pitting edema recorded on Day 0 (M=1.25; SD=0.77) versus Day 90 (M=0.42.48; SD=0.65); t (59) = 12.27; p=0.00. These results demonstrated that there was a marked change in reduced pitting edema score among the subjects of the control group.

There were significant differences between the baseline scores for the 6MWT Day 0 (M=330.97; SD=90.87) versus Day 90 (M=355.48; SD=0.65); t (59) =-4.28; p=0.00. The results were statistically significant. The subjects of the intervention group walking distance in six minutes at 90 days were farther than baseline after using the HFAA.
In summary, for the intervention group, there were no differences between the baseline and Day-90 measurements for systolic blood pressure and diastolic blood pressure among subjects who used the HFAA; however, there were significant differences between the baseline and Day-90 measurements for pitting edema and the 6MWT.

**Comparison between the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, 6MWT scores, and readmission rates recorded at Day 90**

A comparison between the intervention and control groups regarding the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, 6MWT scores, and readmission rates recorded at Day 90 were presented in Table 9.

### Table 9.

**Mean Differences in Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, 6MWT Scores, and Readmission Rates at Day 90 (Intervention versus Control; N=120)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Intervention</td>
<td>115.10</td>
<td>12.413</td>
<td>-.192</td>
<td>118</td>
<td>.85</td>
<td>-6.226 to 5.126</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>115.65</td>
<td>18.409</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Intervention</td>
<td>68.70</td>
<td>11.169</td>
<td>-1.035</td>
<td>118</td>
<td>.30</td>
<td>-7.188 to 2.254</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>71.17</td>
<td>14.706</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Intervention</td>
<td>.42</td>
<td>.645</td>
<td>-4.558*</td>
<td>118</td>
<td>.00</td>
<td>-1.028 to -.405</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.13</td>
<td>1.033</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6MWT</td>
<td>Intervention</td>
<td>355.48</td>
<td>74.495</td>
<td>2.600**</td>
<td>118</td>
<td>.01</td>
<td>10.220 to 75.547</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>312.60</td>
<td>103.800</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Readmission</td>
<td>Intervention</td>
<td>.03</td>
<td>.181</td>
<td>-2.040*</td>
<td>118</td>
<td>.04</td>
<td>-.230 to -.003</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>.15</td>
<td>.404</td>
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</tr>
</tbody>
</table>

*Note.** **p<0.01; * p<0.05; CI=confidence interval; LL=lower limit; UL=upper limit.*

An independent sample t-test was conducted to compare the intervention and control groups regarding systolic blood pressure, diastolic blood pressure, pitting edema, 6MWT scores, and readmission rates recorded on Day 90. The Sig. (2-Tailed) value for systolic blood pressure was greater than .05. There was no statistically significant difference between the mean systolic blood pressure of the intervention group (M=115.103; SD=12.413) and that of the control group.
(M=115.65; SD=18.409); t(118) =-.192; p>0.05 (2-tailed). The mean difference=-.550; (95% CI: -6.226 to 5.126). These results suggest that there were no significant differences in systolic blood pressure measured at Day 90 between the intervention and control groups.

The Sig. (2-Tailed) value for diastolic blood pressure was greater than .05. There was no statistically significant difference in mean diastolic blood pressure between the intervention group (M=68.70; SD=11.17) and that of the control group (M=71.17; SD=14.70); df=110.07; p=0.30 (2-tailed). The mean difference=-2.47; (95% CI: -7.19 to -2.26). It can be concluded that the Day-90 diastolic blood pressure of the intervention group did not significantly decrease compared to the control group.

The Sig. (2-Tailed) value for pitting edema was less than .01. There was a statistically significant difference in mean pitting edema between the intervention group (M=.42; SD=.645) and that of the control group (M=1.13; SD=1.033); t(118)=-4.558; p<0.01 (2-tailed). The mean difference=-.717; (95% CI: -1.028 to - .405). These results suggest that there were significant differences between the two groups in pitting edema measured at Day 90.

The Sig. (2-Tailed) value for the 6MWT scores was less than .05 (p=.01). There was a statistically significant difference in the mean 6MWT scores of the intervention group (M=355.48; SD=74.50) and that of the control group (M=312.60; SD=103.80); df=107.03; p=.01 (2-tailed). The mean difference =42.88; (95% CI: 10.19 to 75.58). These results indicate that the 6MWT scores of the intervention group were significantly higher (i.e., the subjects could walk farther) than those of the control group.

The Sig. (2-Tailed) value for readmission rates was less than .05. There was a statistically significant difference in mean readmission rates of the intervention group (M=0.03; SD=0.18; range=1) and those of the control group (M=0.15; SD=.404; range=2); df=118; p=.04 (2-tailed).
The mean difference = -0.06; (95% CI: -.230 to -.003). It can be concluded that the readmission rates of the intervention group had significantly decreased at Day 90 compared to those of the control group.

In summary, the results suggest that there were no significant differences in systolic blood pressure and diastolic blood pressure measured at Day 90 between the subjects who used the HFAA and those who received routine care; however, the readmission rates among the intervention group had significantly decreased at Day 90 compared to the control group. The 6MWT scores were significantly higher (i.e., the subjects could walk farther) than those of the control group. There were significant differences in the Day-90 measurements for pitting edema between the two groups as well.

**The effects of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores at Day 0, Day 30, Day 60, and Day 90 of intervention group**

The measurements for the intervention group were shown in Table 10.

Table 10.

*The Effect of Time on Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores (Intervention Group; N=60)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>M</th>
<th>SD</th>
<th>λ</th>
<th>df</th>
<th>F</th>
<th>Error</th>
<th>p</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
<td>114.32</td>
<td>19.02</td>
<td>.97</td>
<td>3</td>
<td>.564</td>
<td>57</td>
<td>.64</td>
<td>.64</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>116.63</td>
<td>17.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>116.98</td>
<td>17.34</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Day 90</td>
<td>115.10</td>
<td>12.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>68.53</td>
<td>12.77</td>
<td>.994</td>
<td>3</td>
<td>.121</td>
<td>57</td>
<td>.94</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>69.13</td>
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<td>68.23</td>
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<td></td>
<td>Day 90</td>
<td>68.70</td>
<td>11.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Baseline</td>
<td>1.25</td>
<td>.77</td>
<td>.275</td>
<td>3</td>
<td>50.14</td>
<td>57</td>
<td>.00**</td>
<td>.76</td>
</tr>
<tr>
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<td>Day 30</td>
<td>.97</td>
<td>.71</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>.58</td>
<td>.62</td>
<td></td>
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<td></td>
<td>Day 90</td>
<td>.42</td>
<td>.65</td>
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<tr>
<td>Variables</td>
<td>Time</td>
<td>M</td>
<td>SD</td>
<td>λ</td>
<td>df</td>
<td>F</td>
<td>Error</td>
<td>p</td>
<td>η_p²</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------</td>
<td>------</td>
<td>----</td>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>6MWT</td>
<td>Baseline</td>
<td>330.97</td>
<td>90.869</td>
<td>.763</td>
<td>1</td>
<td>18.33</td>
<td>59</td>
<td>.00**</td>
<td>.24</td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>355.48</td>
<td>74.495</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note* **p<0.01

For the intervention group a repeated measures MANCOVA was conducted to compare the effects of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores at Day 0, Day 30, Day 60, and Day 90. The results of the repeated measures MANCOVA showed that there were no significant differences between the measurements for systolic blood pressure over time (λ=.966; F(3,57)=.564; p=.64), as well as the measurements for diastolic blood pressure over time (λ=.994; F(3,57)=.121; p=.94).

There were significant differences between the measurements for pitting edema over time (λ=.275; F(3,57)=50.14; p<.01; η²=.76). There was a significant interval between time points, most notably between the Day-30 measurement (M=.97; SD=.71) and the Day-60 (M=.58; SD=.62) and Day-90 measurements (M=.42; SD=.65). These results suggest that improvements occurred between Day 30 and Day 60; however, no other significant changes emerged between the intervals.

There were significant differences between the 6MWT scores over time (λ=.763; F(1,57)=18.326; p=.00). There was a significant interval between time points, most notably between the baseline measurement (M=330.97; SD=.90.87) and the Day-90 measurement (M=355.48; SD=74.50). These results suggest that improvements occurred between Day 0 and Day 90; however, no other significant changes emerged between the intervals.

In summary, there were no significant differences between the measurements for systolic blood pressure and diastolic blood pressure over time; however, there were significant differences between the pitting edema measurements and the 6MWT scores over time.
The effect of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores, controlled for age of intervention group

Age can affect heart function and contribute to the risk of heart attack (AHA, 2016). Therefore, these measurements were controlled for age, as shown in Table 11.

Table 11.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>df</th>
<th>F</th>
<th>P</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
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<td>0.24</td>
<td>.961</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>6</td>
<td>1.105</td>
<td>.372</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>6</td>
<td>1.007</td>
<td>.430</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>6</td>
<td>0.121</td>
<td>.993</td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>6</td>
<td>0.887</td>
<td>.511</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>6</td>
<td>1.167</td>
<td>.338</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>6</td>
<td>0.668</td>
<td>.676</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>6</td>
<td>2.000</td>
<td>.082</td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Baseline</td>
<td>6</td>
<td>1.299</td>
<td>.274</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>6</td>
<td>0.417</td>
<td>.864</td>
<td></td>
</tr>
<tr>
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<td>Day 60</td>
<td>6</td>
<td>0.904</td>
<td>.499</td>
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</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>6</td>
<td>0.039</td>
<td>.411</td>
<td></td>
</tr>
<tr>
<td>6MWT</td>
<td>Baseline</td>
<td>6</td>
<td>0.761</td>
<td>.604</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>6</td>
<td>1.512</td>
<td>.192</td>
<td></td>
</tr>
</tbody>
</table>

After controlling for age, no significant differences were found between the baseline (F[6,53]=.24; p=.961), Day-30 (F[6,53]=1.105; p=.372), Day-60 (F[6,53]=1.007; p=.430), and Day-90 (F[6,53]=.121; p=.993) measurements for systolic blood pressure. These results indicate that age was not correlated with systolic blood pressure.

Similarly, no significant differences were identified between the baseline (F[6,53]=.887; p=.311), Day-30 (F[6, 53]=1.167; p=.338), Day-60 (F[6,53]=.668; p=.676), and Day-90 (F[6,53]=2.000; p=.082) measurements for diastolic blood pressure controlled for age. These results show that age was not correlated with diastolic blood pressure.
There were no significant differences between the baseline (F[6,53]=1.299; p=.274), Day-30 (F[6,53]=.417; p=.864), Day-60 (F[6,53]=.039; p=.411), and Day-90 (F[6,53]=.039; p=.411) measurements for pitting edema controlled for age. These results suggest that while pitting edema did decrease over time, with the largest change occurring between Day 30 and Day 60, age did not play a significant role in these changes.

There were no significant differences between the baseline (F[6,53]=0.761; p=.604), Day-90 (F[6,53]=1.512; p=.192) 6MWT scores controlled for age. It can be concluded that age did not influence the intervention subjects’ walking distance at Day 0 and Day 90.

In summary, the results showed that age was not correlated with systolic blood pressure, diastolic blood pressure, pitting edema, nor 6MWT scores.

According to Zimmerman, Woolf, and Haley (2015), education has an impact on understanding, problem-solving, and self-control skills that could contribute to an individual’s health outcomes. Therefore, the researcher controlled for education level in this study, as shown in Table 12.

The effects of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores, controlled for education of intervention group

Table 12.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
<td>3</td>
<td>0.333</td>
<td>.802</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>3</td>
<td>0.420</td>
<td>.740</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>3</td>
<td>0.166</td>
<td>.950</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>3</td>
<td>0.182</td>
<td>.908</td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>3</td>
<td>0.241</td>
<td>.867</td>
<td>56</td>
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<td></td>
<td>Day 30</td>
<td>3</td>
<td>1.717</td>
<td>.174</td>
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<td></td>
<td>Day 60</td>
<td>3</td>
<td>0.196</td>
<td>.899</td>
<td></td>
</tr>
</tbody>
</table>
After controlling for education level, no significant differences were found between the baseline (F[6,56]=.333; p=.802), Day-30 (F[6,56]=.420; p=.740), Day-60 (F[6,56]=.166; p=.950), and Day-90 (F[6,56]=.182; p=.908) measurements for systolic blood pressure. These results show that education level was not correlated with systolic blood pressure.

Similarly, there were no significant differences between the baseline (F[6,56]=.241; p=.867), Day-30 (F[6,56]=1.717; p=.174), Day-60 (F[6,56]=.196; p=.899), and Day-90 (F[6,56]=.856; p=.470) measurements for diastolic blood pressure controlled for education level. These results indicate that education level was not associated with diastolic blood pressure.

There were no significant differences in pitting edema controlled for education level, as seen in the baseline (F[6,56]=.629; p=.600), Day-30 (F[6,56]=1.085; p=.363), Day-60 (F[6,56]=1.505; p=.223), and Day-90 (F[6,56]=2.143; p=.105) measurements. These results suggest that while there were decreases in pitting edema over time, education level does not play a significant role in these changes.

There were no significant differences in the 6MWT scores controlled for education level, as evidenced by the baseline (F[6,56]=02.092; p=.112), and Day-90 (F[6,56]=2.590; p=.062) measurements. It can be concluded that education level did not influence the intervention subjects’ walking distance at Day 0 and Day 90.
In summary for the control group, the results show that education level was not affected with systolic blood pressure, diastolic blood pressure, pitting edema, nor 6MWT scores.

**The effect of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores of control group**

The measurements were shown in Table 13.

Table 13.

*The Effect of Time on Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores (Control Group; N=60)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>M</th>
<th>SD</th>
<th>λ</th>
<th>df</th>
<th>F</th>
<th>Error</th>
<th>p</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
<td>121.05</td>
<td>20.07</td>
<td>.870</td>
<td>3</td>
<td>2.85</td>
<td>57</td>
<td>.05*</td>
<td>.13</td>
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<tr>
<td></td>
<td>Day 30</td>
<td>113.85</td>
<td>20.24</td>
<td></td>
<td></td>
<td></td>
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<td>115.65</td>
<td>18.41</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>68.67</td>
<td>12.66</td>
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<td>3</td>
<td>2.20</td>
<td>57</td>
<td>.10</td>
<td>.10</td>
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<tr>
<td></td>
<td>Day 30</td>
<td>66.25</td>
<td>12.79</td>
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<td></td>
</tr>
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<td></td>
<td>Day 60</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>71.17</td>
<td>14.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Baseline</td>
<td>2.23</td>
<td>7.62</td>
<td>.979</td>
<td>3</td>
<td>.41</td>
<td>57</td>
<td>.75</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>1.15</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>1.12</td>
<td>.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>1.13</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6MWT</td>
<td>Baseline</td>
<td>324.43</td>
<td>107.87</td>
<td>.763</td>
<td>1</td>
<td>1.541</td>
<td>59</td>
<td>.219</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>312.60</td>
<td>103.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Note* *p*<0.05

A repeated measures MANOVA was performed on the control data, comparing the effect of time on systolic blood pressure diastolic blood pressure, pitting edema, and 6MWT scores at Day 0, Day 30, Day 60, and Day 90. The results of the repeated measures MACNOVA showed significant differences between the measurements for systolic blood pressure over time (λ=.870; F[3,57]=.2.85; p=.05; η²=.13). There was a significant interval between time points, most notably between the Day-30 measurement (M=113.85; SD=20.24) and the Day-60 (M=118.32;
SD=20.02) and Day-90 measurements (M=118.41; SD=.41). These results suggest that improvements occurred between Day 30 and Day 60; however, no other significant changes emerged between the intervals.

In summary, the control group demonstrated no significant differences in diastolic blood pressure, pitting edema, and 6MWT scores over time; however, there were significant differences between the measurements for systolic blood pressure over time.

The effect of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6mwt scores, controlled for age of control group

Table 14.

The Effect of Time on Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores, Controlled for Age (Control Group; N=60)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
<td>4</td>
<td>1.044</td>
<td>.393</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>4</td>
<td>1.213</td>
<td>.316</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>4</td>
<td>.604</td>
<td>.661</td>
<td></td>
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<td></td>
<td>Day 90</td>
<td>4</td>
<td>1.530</td>
<td>.206</td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>4</td>
<td>1.014</td>
<td>.408</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>4</td>
<td>.144</td>
<td>.965</td>
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<tr>
<td></td>
<td>Day 60</td>
<td>4</td>
<td>.165</td>
<td>.955</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>4</td>
<td>1.687</td>
<td>.166</td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Baseline</td>
<td>4</td>
<td>1.788</td>
<td>.144</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Day 30</td>
<td>4</td>
<td>1.233</td>
<td>.308</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 60</td>
<td>4</td>
<td>2.719</td>
<td>.039*</td>
<td></td>
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<td></td>
<td>Day 90</td>
<td>4</td>
<td>.735</td>
<td>.572</td>
<td></td>
</tr>
<tr>
<td>6MWT</td>
<td>Baseline</td>
<td>4</td>
<td>2.159</td>
<td>.086</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Day 90</td>
<td>4</td>
<td>2.507</td>
<td>.056</td>
<td></td>
</tr>
</tbody>
</table>

Note * p<0.05

After controlling for age, no significant differences were found between the baseline (F[4,55]=1.044; p=.393), Day-30 (F[4,55]=1.213; p=.316), Day-60 (F[4,55]=.604; p=.661), and Day-90 (F[4,55]=1.530; p=.206) measurements for systolic blood pressure. These results showed that age was not correlated with systolic blood pressure.
Similarly, there were no significant differences between the baseline (F[4,55] = 1.014; p = .408), Day-30 (F[4,55] = 1.144; p = .965), Day-60 (F[4,55] = .165; p = .955), and Day-90 (F[4,55] = 1.687; p = .166) measurements for diastolic blood pressure controlled for age. These results indicated that age was not correlated with diastolic blood pressure.

There were significant differences between the baseline (F[4,55] = 1.788; p = .144), Day-30 (F[4,55] = 1.233; p = .308), Day-60 (F[4,55] = 2.719; p = .039), and Day-90 (F[4,55] = 1.687; p = .572) measurements for pitting edema controlled for age. These results suggest that while pitting edema decreased over time, with the largest change occurring between Day 30 and Day 60, age did not play a significant role in these changes.

There were no significant differences in the 6MWT scores controlled for age, as seen in the baseline (F[4,55] = 2.159; p = .086) and Day-90 (F[4,55] = 2.507; p = .056) measurements. It can be concluded that age does not influence the control subjects’ walking distance at Day 0 and Day 90.

In summary, the findings suggest that age was not correlated with systolic blood pressure, diastolic blood pressure, and 6MWT scores. While there were marked decreases in pitting edema between Day 30 and Day 60, age did not play a significant role in these changes among the control group.

The effect of time on systolic blood pressure, diastolic blood pressure, pitting edema, and 6MWT scores, controlled for education level of control group

These measurements were then controlled for education level, as shown in Table 15.
Table 15.

The Effect of Time on Systolic Blood Pressure, Diastolic Blood Pressure, Pitting Edema, and 6MWT Scores, Controlled for Education Level (Control Group; N=60)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>df</th>
<th>F</th>
<th>P</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td>Baseline</td>
<td>4</td>
<td>1.405</td>
<td>.244</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>30 Day</td>
<td>4</td>
<td>2.301</td>
<td>.070</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 Day</td>
<td>4</td>
<td>1.544</td>
<td>.202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 Day</td>
<td>4</td>
<td>0.424</td>
<td>.709</td>
<td></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Baseline</td>
<td>4</td>
<td>1.455</td>
<td>.229</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>30 Day</td>
<td>4</td>
<td>0.330</td>
<td>.856</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 Day</td>
<td>4</td>
<td>1.603</td>
<td>.186</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 Day</td>
<td>4</td>
<td>0.376</td>
<td>.825</td>
<td></td>
</tr>
<tr>
<td>Pitting edema</td>
<td>Baseline</td>
<td>4</td>
<td>1.245</td>
<td>.303</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>30 Day</td>
<td>4</td>
<td>0.613</td>
<td>.655</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 Day</td>
<td>4</td>
<td>0.463</td>
<td>.763</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 Day</td>
<td>4</td>
<td>0.434</td>
<td>.783</td>
<td></td>
</tr>
<tr>
<td>6MWT</td>
<td>Baseline</td>
<td>4</td>
<td>1.902</td>
<td>.123</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>90 Day</td>
<td>4</td>
<td>1.899</td>
<td>.124</td>
<td></td>
</tr>
</tbody>
</table>

After controlling for education level, no significant differences were found between the baseline (F[4,55]=1.405; p=.244), Day-30 (F[4,55]=2.301; p=.070), Day-60 (F[4,55]=1.544; p=.202), and Day-90 (F[4,55]=.424; p=.709) measurements for systolic blood pressure. These results show that education level was not correlated with systolic blood pressure.

There were no significant differences between the baseline (F[4,55]=1.455; p=.229), Day-30 (F[4,55]=.330; p=.856), Day-60 (F[4,55]=1.603; p=.186), and Day-90 (F[4,55]=.376; p=.825) measurements for diastolic blood pressure controlled for education level. These results indicate that education level was not associated with diastolic blood pressure.

There were no significant differences in pitting edema controlled for education level, as evidenced in the baseline (F[4,55]=1.245; p=.303), Day-30 (F[4,55]=.613; p=.655), Day-60 (F[4,55]=.463; p=.763), and Day-90 (F[4,55]=0.434; p=.783) measurements. These results suggest that while pitting edema did not decrease over time, education level did not play a significant role in these changes.
There were no significant differences between the 6MWT scores controlled for education level, as seen in the baseline (F[4,55]=1.902; p=.123) and Day-90 (F[4,55]=1.899; p=.124) measurements. It can be concluded that age did not influence the control subjects’ walking distance at Day 0 and Day 90.

In summary, education level was not correlated with systolic blood pressure, diastolic blood pressure, pitting edema, nor 6MWT scores.

**Hypotheses Testing**

**First Hypothesis**

The researcher hypothesized that Thai patients with HF who use the HFAA will demonstrate improvements in the 6MWT compared to those who do not use the mobile app. The following methods were used to test this hypothesis.

A repeated measured MANCOVA was conducted to compare the effect of time on the subjects’ 6MWT scores at Day 0 and Day 90. The results showed that there were significant differences between the 6MWT scores over time in the intervention group (λ=.763; F[1,57]=18.326; p=.00; see Table 10.1), whereas there were no significant differences between the 6MWT scores over time in the control group (λ=.975; F[1,59]=1.541; p=.219; see Table 11.1). No other significant changes emerged between the intervals in both groups.

A paired sample t-test was also conducted to determine the effects of two covariates (i.e., age and education level) on physical function (i.e., walking). After controlling for the covariates, no significant differences were found between the baseline and Day-90 measurements for the 6MWT. These results indicate that neither age nor education level influenced the subjects’ walking
distance in both groups (see Tables 10.2 and 11.2 for age; see Tables 10.3 and 11.3 for education level).

An independent samples t-test was conducted to compare the subjects’ physical function, which was measured by the 6MWT at Day 90. The Sig. (2-Tailed) value for the 6MWT scores was less than .05 (p=.01). There was a statistically significant difference between the mean 6MWT scores of the intervention group (M=355.48; SD=74.50) and those of the control group (M=312.60; SD=103.80); group: t(118)=2.600; p<0.01 (2-tailed). The mean difference=42.88; (95% CI: 10.22 to 75.55) (see Table 9). These results suggest that there were significant differences in the 6MWT Day-90 measurements between the two groups.

In conclusion, Thai patients with HF who used the HFAA demonstrated improvements in the 6MWT compared to those who did not use the mobile app. They also improved from baseline to 90 days and differed from control group. The null hypothesis of no difference was rejected and the hypothesis as stated was accepted.

**Second Hypothesis**

The researcher hypothesized that Thai patients with HF who use the HFAA mobile app will demonstrate lower blood pressure compared to those who do not use the mobile app. The following methods were used to test this hypothesis.

**Systolic blood pressure.** A repeated measures MANCOVA resulted in no significant differences between the measurements for systolic blood pressure over time in the intervention group (λ=.966; F[3,57]=.564; p=.64; see Table 10). However, significant differences were found between the measurements for systolic blood pressure over time in the control group (λ=.870; F[3,57]=2.85; p=.05; η²=.13; see Table 14). These differences emerged between the Day-30
measurement (M=113.85; SD=20.24) and the Day-60 (M=118.32; SD=20.02) and Day-90 measurements (M=118.41; SD=.41). These results suggest that improvements occurred between Day 30 and Day 60 in the control group; however, no other significant changes emerged between the intervals. In summary, there were no significant differences between the measurements for systolic blood pressure over time in both groups.

A repeated measures MANCOVA was also conducted to determine the effects of two covariates (i.e., age and education level) on physical function (i.e., systolic blood pressure and diastolic blood pressure). After controlling for the covariates, no significant differences were found between the baseline and Day-90 measurements for systolic blood pressure in both groups (see Table 10.2 and 11.2). These results indicate that neither age nor education level were correlated with systolic blood pressure.

An independent samples t-test was conducted to compare the Day-90 measurements for systolic blood pressure in both groups. The Sig. (2-Tailed) value for systolic blood pressure was greater than .05. There was no statistically significant difference between the mean systolic blood pressure of the intervention group (M=115.103; SD=12.413) and that of the control group (M=115.65; SD=18.409); group: t(118)=-.192; p>0.05 (2-tailed). The magnitude of the differences in the mean are displayed in Table 9 (mean difference=-.550, 95% CI: -6.226 to 5.126). These results suggest that there were no significant differences in systolic blood pressure measured at Day 90 between both groups.

**Diastolic blood pressure.** A repeated measures MANCOVA resulted in no significant differences between the measurements for diastolic blood pressure over time in both the intervention group (λ=.994; F[3,57]=.121; p=.94) and the control group (λ=.896; F[3,57]=.20; p=.10).
An independent samples t-test was conducted to compare diastolic blood pressure measured at Day 90 in both groups. The Sig. (2-Tailed) value for diastolic blood pressure was greater than .05. There was no statistically significant difference between the mean diastolic blood pressure of the intervention group (M=68.70; SD=11.169) and that of the control group (M=71.17; SD=14.706); group: t(118)=-1.035; p>0.05 (2-tailed). The mean difference=-2.467 (95% CI: -7.188 to 2.254; see Table 9). These results suggest that there were no significant differences in diastolic blood pressure measured at Day 90 between both groups.

In conclusion, the Thai patients with HF who used the HFAA did not demonstrate any differences in systolic blood pressure and diastolic blood pressure compared to those who did not use the mobile app. The null hypothesis of no difference was not rejected and the hypothesis as stated was rejected.

Third Hypothesis

The researcher hypothesized that fewer Thai patients with HF who use the HFAA will experience episodes of pitting edema compared to those who do not use the mobile app. The following methods were used to test this hypothesis.

A repeated measures MANCOVA resulted in significant differences between the measurements of pitting edema over time in the intervention group (λ=.275; F[3,57]=50.14; p<.01; η²=.76; see Table 10.1). There were no significant differences between the measurements of pitting edema over time in the control group (λ=.979; F[3,57]=.41; p=.75; see Table 11.1). In summary, there were no significant differences between the measurements of pitting edema over time in control groups while there were significant differences in the intervention group.

A repeated measures MANCOVA was conducted to determine the effects of two covariates (i.e., age and education level) on physical function (i.e., pitting edema). The results suggest that
while pitting edema decreases over time, neither age nor education level play a role in these changes experienced by both groups (see Tables 10.2, 10.3, 11.2, and 11.3).

An independent samples t-test was conducted to compare physical function, which was measured by comparing pitting edema at Day 90 in both groups. The Sig. (2-Tailed) value for pitting edema was less than .01. There was a statistically significant difference between the mean pitting edema measurements of the intervention group (M=.42; SD=.645) and those of the control group (M=1.13; SD=1.033); group: t(118)=-4.558, p<0.01 (2-tailed). The mean difference=-.717; (95% CI: -1.028 to -.405; see Table 9). These results suggest that there were significant differences in pitting edema measured at Day 90 between the two groups.

In conclusion, fewer Thai patients with HF who used the HFAA experienced episodes of pitting edema compared to those who did not use the mobile app. The null hypothesis of no difference was rejected and the hypothesis as stated was accepted.

Fourth Hypothesis

The researcher hypothesized that Thai patients with HF who use the HFAA will demonstrate lower hospital readmission rates compared to those who do not use the mobile app. The following methods were used to test this hypothesis.

An independent samples t-test was conducted to compare the hospital readmission rates measured at Day 90. There were significant differences between the intervention (M=0.03; SD=.181) and control groups (M=.15; SD=.404); t(118)=-2.040; p<.05 (see Table 9). These results suggest that the intervention group had fewer hospital readmissions than the control group. The null hypothesis of no difference was rejected and the hypothesis as stated was accepted.
Summary of the Findings

The current chapter presented the findings of the study, describing the individual demographics of the 120 subjects, including age, gender, race, marital status, education level, occupation, total household income per year, etiology of HF, and prescription medication. The eight instruments used in the study were evaluated and demonstrated satisfactory reliability.

A paired sample t-test was conducted to compare the mean differences in systolic blood pressure, diastolic blood pressure, pitting edema, 6MWT scores, and readmission rates at Day 0 and Day 90. In the intervention group, significant differences were found in the mean measurements of pitting edema and readmission rates; however, there were no significant differences in systolic blood pressure and diastolic blood pressure. In the control group, a significant difference was found in systolic blood pressure; however, there were no significant differences in diastolic blood pressure, pitting edema, and the 6MWT scores.

The four research hypotheses were tested using repeated measures MANCOVA to test differences over time, which tests whether differences exist in the results when controlled for age and education level. The independent sample t-tests assessed differences in hospital readmission rates between the two groups. The first, third, and fourth hypotheses were supported by the findings: Thai patients with HF who used the HFAA demonstrated more improvements in the 6MWT (H1) and experienced fewer hospital readmissions (H4), and fewer patients who used the HFAA experienced episodes of pitting edema (H3) compared to those who did not use the mobile app. The second hypothesis was not supported: Thai patients with HF who used the HFAA did not demonstrate any differences in systolic blood pressure and diastolic blood pressure compared to those who did not use the mobile app.
CHAPTER V: DISCUSSION, CONCLUSION, IMPLICATIONS, AND RECOMMENDATIONS

Purpose and Hypotheses

This chapter presents a summary of the study findings. The research limitations and implications for practice and education are also discussed. Finally, possible directions for future research are provided.

The purpose of this study was to determine the feasibility of using the Heart Failure Aide Application (HFAA) to measure physical functions and hospital readmission rates among Thai patients with heart failure (HF). The dependent variables included hospital readmission rates, systolic and diastolic blood pressure (BP), six-minute walk test (6MWT) scores, and episodes of pitting edema. Four hypotheses were tested:

H1: Thai patients with HF who use the HFAA will demonstrate improvements in the six-minute walk test (6MWT) compared to those who do not use the mobile app.

H2: Thai patients with HF who use the HFAA will demonstrate lower blood pressure compared to those who do not use the mobile app.

H3: Fewer Thai patients with HF who use the HFAA will experience episodes of pitting edema compared to those who do not use the mobile app.

H4: Thai patients with HF who use the HFAA will demonstrate lower hospital readmission rates compared to those who do not use the mobile app.

Discussion of Research Findings

Theoretical Framework

Self-management in Chronic Illness (SMCI) theory served as a framework for discussing the findings of the present study, as the goal was to test self-management using the HFAA.
among HF patients in Thailand. The SCMI theory is concerned with six skills: “problem solving,” “decision making,” “resource utilization,” “formation of a patient–provider partnership,” “action planning,” and “self-tailoring” (Lorig & Holman, 2003, p.1-6). These skills were interpreted through the subjects’ physical functions and readmission rates, as discussed in the following sections.

**Problem-Solving**

Problem-solving encompasses a set of skills, such as “identifying the problem, determining the potential solutions, and selecting the best solution, that individuals can use to solve their health problems” (Lorig & Holman, 2003, pp. 1–6). In the present study, a mobile app (i.e., the HFAA) provided health information and recommendations tailored to each subject, which was found to increase their knowledge and skills in solving problems related to HF. The subjects’ physical functions (i.e., 6MWT scores, BP, pitting edema) were examined at Day 0 (baseline), Day 30, Day 60, and Day 90, and their hospital readmission rates were recorded using the ICD-9 computer system at Day 90, after using the HFAA. This system is operated and controlled by Thailand’s Ministry of Public Health (MoPH).

The researcher compared the systolic and diastolic BP, episodes of pitting edema, 6MWT scores, and readmission rates recorded on Day 90 of the intervention and control groups. Results from the intervention group showed that the p-values for the pitting-edema scores and readmission rates were less than .05. Likewise, p-values for the 6MWT scores were less than .01. These values indicate that the subjects’ physical functions had improved after using the HFAA, as they exhibited fewer episodes of pitting edema, lower readmission rates, and were able to walk the farthest in six minutes, compared to those who received the usual treatment. There is also evidence that the HFAA had a positive effect on the subjects’ individual problem-solving
skills, helping them restrict their fluid intake, identify important signs, readjust their diuretic dosing, and receive alerts related to their health. These skills can lead the individual to a better understanding of their HF and allow them to seek the best possible solutions to any issues.

These findings are like those of previous studies conducted with patients with chronic diseases. In Markowitz, Harrington, and Laffel’s (2013) study, technological applications were found to be particularly suited to problem-solving, as they can be programmed to gather, process, analyze, and communicate data in a way that supports decision making. Similarly, the Mobile Diabetes Detective (MoDD) application is useful for encouraging individuals with type 2 diabetes to self-monitor, reflect, and problem solve. Patients using this app improved glycemic control (Mamykina et al., 2016). Clearly, these mobile applications support self-management in problem-solving by helping patients access information and resources, identify problems, and implement the most effective solution.

**Decision-Making**

Decision-making refers to “the patient’s capacity to make appropriate decisions regarding their symptoms, such as the abilities to identify signs of worsening, determine and prioritize the problems, and select an appropriate solution” (Lorig & Holman, 2003, pp. 1–6). For these skills, patients need sufficient access to correct information on HF, including the appropriate guidelines they should follow (Lorig & Holman, 2003, pp. 1–6).

Results from the present study show in the intervention group where readmission rates and pitting-edema scores had significantly decreased at Day 90, compared to the control group (p<.05). Subjects in the intervention group also demonstrated that they could walk for longer distances during the 6MWT than those in the control group (p<.01). These results show better management of HF symptoms in patients with HF and suggest that use of the HFAA can
significantly improve an HF patient’s decision-making skills, particularly through its alerts whenever the patient experiences a warning sign, helping them avoid fatal complications and make the most appropriate decision for their health. In addition, the HFAA also calculates the diuretics dosage and daily fluid intake for each patient, offering key information for the patient’s decision making.

These findings are supported by Abbasgholizadeh Rahimi, Menear, Robitaille, & Légaré (2017) study, which proposed that mobile apps can encourage higher patient participation in medical decision-making by providing real-time connectivity between healthcare practitioners and patients. They also suggested that mobile technology can support patients in their decision-making without the need to visit a healthcare center, which is especially beneficial for those living in inaccessible areas. Another study indicated that patients who have better health outcomes and healthcare experiences are much more likely to make positive decisions regarding their health (Hibbard & Greene, 2017). Frias et al. (2017) found a similar result when studying the impact of digital medicine offerings (DMOs) on BP and glycosylated hemoglobin (HbA1C) in patients with uncontrolled hypertension and type 2 diabetes. A DMO delivers dose-by-dose advice, ensuring medication adherence to promote patient decision making, thereby resulting in lower BP, HbA1c, and low-density lipoprotein cholesterol (LDL-C) (Frias et al., 2017). Using mobile apps can empower and enhance medical decision-making, raise patient satisfaction by monitoring health conditions, such as fluid overload, and help patients detect life-threatening signs of deterioration at the earliest moment (Abbasgholizadeh Rahimi, Menear, Robitaille, & Légaré, 2017).
Resource Utilization

Resource utilization refers to the patient’s ability to seek out and use resources for their own care. The HFAA provides emergency contact numbers, “health education, and access to healthcare providers, all of which are crucial resources” (Lorig & Holman, 2003, pp. 1–6). The HFAA also offers convenient access to information on heart failure and educates the patient on how to efficiently use and interpret these resources, which can lead to positive health outcomes.

Comparisons between the mean values for pitting-edema scores and readmission rates show that the intervention group demonstrated considerably lower pitting-edema scores and readmission rates at Day 90, compared to the control group (p< .05). The intervention group also walked longer distances in the 6MWT (p<.01). The findings indicated that patients utilized the information and resources to improve health outcomes. The information provided by HFAA included recommended dosage, signs of deterioration, emergency contact numbers, all of which are essential resources for the utilization skill in self-management in HF patients. This is supported by Tripp et al. (2014), who indicated that mobile apps can decrease re-hospitalization by educating patients and permitting them to understand their own conditions, leading to better health management and health outcomes. Similarly, Abaidoo and Larweh (2014) found that information and communication technology (ICT) enhances patients’ resource utilization through immediate and personalized health information sent to patients based on data of individuals’ health conditions.

Formation of a Patient–Provider Partnership

The patient–provider partnership is “fundamental to patients’ abilities to correctly share information about individual health and any deteriorating conditions with their healthcare providers” (Lorig & Holman, 2003, pp. 1–6). The HFAA offers two-way communication
between patients and healthcare providers, allowing patients to report and discuss their health status with their providers. Results from the present study suggested that the HFAA can assist patients with identifying and reporting the most significant signs and symptoms of heart failure, such as dyspnea; fatigue; swelling in legs, ankles, or feet; persistent cough; and sudden weight gain. Early detection of such symptoms may prevent them from becoming life-threatening.

Comparing the mean values for the dependent variables between Day 0 and Day 90 showed that there was difference in diastolic BP, pitting edema, and 6MWT within the intervention group, but the control group showed no difference in BP, pitting edema, and 6MWT. Moreover, there was significantly lower pitting-edema scores and decreased readmission rates at Day 90, and ability to walking farther in the 6MWT in the intervention group than those in the control group.

Many studies support the theory that mobile technology can improve the patient–provider partnership. The Markle Foundation stated that electronic applications allow individuals to “access, manage, and share their health information, and that of others for whom they are authorized, in a private, secure, and confidential environment” (Tang, Ash, Bates, Overhage, & Sands, 2006, p. 122). Tenforde, Jain, and Hickner (2011) indicated that electronic applications can provide two-way communication between healthcare providers and patients that can improve self-management. Abaidoo and Larweh (2014) described the role of information and communication technology (ICT) in enhancing the patient–provider partnership. ICT offers reminders and motivation to patients; electronic information on an individual’s health; and delivery of immediate data on a patient’s health condition to the patient and healthcare provider (Abaidoo & Larweh, 2014).
For HF patients, the HFAA includes diuretic dosage information, blood-pressure monitoring, tools for measuring pitting edema, and the 6MWT. Moreover, the HFAA assists healthcare providers by reporting warning signs (differentiated by color) in patients, allowing them to administer the appropriate interventions.

**Action Planning**

Action planning consists of making a brief list of actions to take in each potential scenario (Lorig & Holman, 2003). The HFAA tracks the patient’s warning signs and symptoms to allow for early detection of worsening heart failure and assists the patient in calculating and administering diuretics. The app also prompts patients to begin a customized action plan when signs of deterioration are identified, which are differentiated using the red–yellow–green color system. As described in Chapter 3, red color in HFAA indicates the participant needs immediate care: she or he must immediately contact the healthcare team and/or urgent admission. Yellow means the participant’s symptoms may require an adjustment of medication; in which case HFAA will provide daily diuretic dose adjustments. The green color in the app signifies that the participant’s symptoms are under control and the participant can continue to take medication as ordered. Patients enter information on their pitting edema, weight, and blood pressure into the app daily, which allows them to make a short, self-managed action plan that can lead to more positive health outcomes and decreased readmission rates.

Based on these findings, the study supports the idea that HF patients can utilize the information and resources available in HFAA to calculate diuretic dosage, identify deteriorations of HF daily and generate an action plan for controlling the disease, all of which enhances HF patients to achieve self-management. These findings are supported by previous studies on chronic diseases. Melanie, Cafazzo, Seto, Chapman, and Casey (2015) examined the usability of
“an Android app to support self-management in patients with chronic obstructive pulmonary disease (COPD) by following and quickly identifying acute exacerbations of COPD every day and stimulating patients to generate an action plan for their acute exacerbations” (p.1). The study indicated that the mobile app increased the patients’ knowledge and abilities to initiate a self-managed action plan (Melanie, Cafazzo, Seto, Chapman, & Casey, 2015). Also, mobile technology that supports self-management in patients with chronic diseases is vital for their survival. Lähdesmäki (2015) stated that self-evaluation of health via mobile app has enormous potential in action planning and implementation. HF patients supported by mobile apps can learn how to form an action plan by tracking their symptoms and identifying signs of deterioration, thereby improving their health outcomes. The adoption of mobile apps by the healthcare system is a massive step toward enhanced self-management in HF patients.

Self-tailoring

Self-tailoring refers to the patients who can alter resources around them enabling them to manage a specific situation (Lorig & Holman, 2003). These results show that HF patients can utilize the information and resources provided by the HFAA that can help HF patients personalize their treatment by reporting changes in their health status every day (i.e., offering advice) and adjusting diuretic dosages accordingly. The app can also recommend several ways to fit the advice it offers into the patient’s regimen, assisting with the challenges of daily life and preventing HF complications. Therefore, the HFAA promotes effective self-monitoring and delivers individually tailored advice to HF patients.

Goyal et al. (2016) indicated that using mobile health apps can facilitate self-monitoring, deliver tailored and actionable knowledge, stimulate positive behavior changes, and promote effective self-management of diabetes. Another study by Hardinge et al. (2015) supported that
mobile technologies can assist patients in managing their conditions by delivering individually tailored education and treatment plans, as well as providing support in monitoring and interpreting their physiological data. Mobile health technology, such as smartphones and tablets, can deliver educational management information systems (EMIs), which includes highly tailored electronic messages, in a patient’s natural setting at a precise time to promote behavior change (Plow, Mangal, Geither, & Golding, 2016). All these studies demonstrate that the transfer of care activities from healthcare providers to patients is achievable by equipping patients with adequate tools that are tailored to their needs (i.e., those that promote self-management). Mobile technology assists patients in choosing, adopting, and maintaining self-care behaviors to deal with more complex issues arising from HF (Stut, Deighan, Cleland, & Jaarsma, 2015).

In the present study, the healthcare providers were able to promote individually tailored SMCI activities via mobile technology, thereby supporting the patients with HF in self-managing their condition (DelaCruz, 2015). In this way, patients become real partners in the care process, and healthcare providers can increase their focus on the treatment of more serious health conditions (Abaidoo & Larweh, 2014). As the HFAA provides individually tailored education and treatment plans that are offered daily and easy to access, their use increases patients’ abilities in their day-to-day lives, and helps prevent HF complications.

**Discussion of the Research Hypotheses**

There were four research hypotheses in the present study, of which only the second hypothesis was not supported. The hypotheses were tested using a repeated measures ANOVA (RM-ANOVA) to determine the differences in BP and pitting edema between the Day 0 (baseline) and Day-90 (post-intervention) measurements, then the repeated measures MANCOVA to control for the impact of age and education level on BP, pitting edema, and the
6MWT. A paired sample t-test was conducted to compare the mean 6MWT scores at baseline and Day 90. Using an independent samples t-test, the researcher compared the mean readmission rates between the intervention and control groups.

**First Hypothesis**

The researcher hypothesized that Thai patients with HF who use the HFAA will demonstrate improvements in the 6MWT compared to those who do not use the mobile app. This hypothesis was supported.

When comparing the 6MWT scores between Day 0 and Day 90, significant differences were found in the intervention group (p<.01), whereas no significant differences were found in the control group (p>.05). However, there are significant differences between the two groups in the 6MWT scores at Day 90. Neither age nor education level were found to influence the subjects’ walking distance in both groups.

This hypothesis was proposed because the HFAA provides effective recommendations for improving self-management behaviors, including taking daily weight measurements to monitor fluid intake, calculating the diuretic dosages and fluid restrictions for each individual, and providing alerts for warning signs and health information to the patient. These features promoted the patients’ physical functions, such as walking capacity, activity tolerance, and weight control.

Many studies support the hypothesis that HFAA can improve greater walk distance during the 6MWT. Lähdesmäki (2015) used a mobile health intervention to remotely observe the patients’ body weight, blood pressure, and symptoms, determining whether the intervention could improve physical outcomes such as better walk during the 6MWT. Worringham, Rojek, and Stewart (2011) examined the feasibility of a smartphone app to remotely monitor exercise
activities in patients with a history of cardiac arrest. Their results showed that the patients achieved a greater walk distance during the 6MWT, from 524 to 637 meters, confirming that using a smartphone app to monitor health can improve HF patients’ physical capabilities. Martin et al. (2015) studied the effect of a mobile health (mHealth) intervention, with tracking and texting components, on physical activity. They found that subjects who received the SMS messages took 3,376 steps more than the blinded control group. Similarly, Maddison et al. (2015) studied the effectiveness of a mobile-phone intervention on exercise and physical activity in patients with ischemic heart disease (IHD). The results showed that the intervention group walked more (512 vs. 361 min/week; p=0.02) and enjoyed greater improvements in general health, compared to the control group (Maddison et al., 2015). Widmer, Allison, Lerman, & Lerman (2015) tested the feasibility of using a digital health intervention (DHI) as an adjunct to traditional cardiac rehabilitation (CR) over three months. The results revealed significant improvements in physical function and exercise capacity among the subjects who used the DHI (Widmer et al., 2015). Maddison et al., (2015) examined the effect of a mobile phone intervention in patients with cardiovascular disease, and the intervention group reported longer walking distances in the 6MWT (measured at baseline and post-intervention) than the control group.

Moreover, Ong et al. (2016) stated that patients who had received usual care had lower self-management than patients who used mobile technologies. The poor self-management resulted in lower functional capacity and health outcomes (Ong et al., 2016). This related to the statement of Lorig and Holman (2003) that patients with HF, who had low self-management, found it difficult to monitor their symptoms, to interpret weight fluctuations, and to care for themselves without delay. The poor self-management was likely associated with the patients’
delayed decision making; poor medication adherence which decreased physical function, such as walking; and increased hospital readmission rate (Lorig & Holman, 2003). It is clear that HFAA can improve self-management in patients with HF leading them to have longer walking distances in the 6MWT.

Second Hypothesis

The researcher hypothesized that Thai patients with HF who use the HFAA mobile app will demonstrate lower blood pressure compared to those who do not use the mobile app. This hypothesis was rejected based upon this study’s results.

When comparing BP at Day 90 between the two groups, no statistically significant difference was found between the mean systolic BP measurements (p > 0.05; 2-tailed) nor the diastolic BP measurements (p > 0.05). There were no significant differences between the measurements for systolic BP at baseline, Day 30, Day 60, and Day 90 in the intervention group (p > 0.05). In the control group, however, there were significant differences in systolic BP (p < 0.05) between the Day-30 (M=113.85; SD=20.24) and Day-60 (M=118.32; SD=20.02) measurements. However, no other significant changes emerged between the intervals. There were no significant differences between the measurements for diastolic BP over time in both the intervention group (p > 0.94) and the control group (p > 0.10). Age and education level were used to determine the effects on BP. Neither age nor education level influenced the subjects’ BP in both groups.

The prior study indicated that the mobile application could not reduce blood pressure but could affect weight and body mass index (Widmer et al., 2015). Accordingly, Chen et al. (2013) found that mobile tele-health used to communicate between patients and healthcare providers to reduce BP did not significantly serve its purpose. Suh et al. (2011) stated that lack of guidance when taking medication, such as angiotensin-converting enzyme inhibitors, β-blockers, and
aldosterone receptor antagonists, could lead to adverse health outcomes in patients with HF. Additionally, HF frequently causes systolic dysfunction, which can contribute to inadequate pumping of the heart. Patients with HF require treatments that emphasize BP regulation and medication adjustment (Vasan et al., 2001). The present study theorized that the HFAA could assist HF patients with adjusting their diuretic dosages and adhering to their medications prescribed, but perhaps could not decrease BP because, typically, patients with HF take other medications in addition to diuretics. Furthermore, regular exercise, diet control, and stress control are also needed for control of BP (Widmer, Collins, Collins, West, Lerman & Lerman, 2015). Thus, the HFAA is not enough to control BP in the patients with HF. Other tools for promoting medication adherence are needed.

**Third Hypothesis**

The researcher hypothesized that fewer Thai patients with HF who use the HFAA will experience episodes of pitting edema compared to those who do not use the mobile app. This hypothesis was supported.

When comparing the subjects’ pitting edema at Day 0 and Day 90, there were significant differences over time in the intervention group (p<.01), but no significant differences over time in the control group (p>.05). At Day 90, there were significantly fewer episodes of pitting edema in the intervention group than the control group (p<.01). Neither age nor education level played a role in the changes experienced by both groups.

This hypothesis was proposed because the HFAA includes assistance and recommendations for self-care, calculates the daily diuretic dosages and fluid intake for each patient, provides color-coded health alerts (green, yellow, or red), and offers health information to the patient. To reduce fluid overload and improve medication management, the HFAA
analyzes the patients’ weight and the pitting-edema measurements, which are entered by the patient to compile a daily report on the appropriate diuretic dose.

Many studies support the effective health outcomes of using mobile apps to reduce pitting edema. A pilot study tested the feasibility of using a mobile app (HeartMapp) to improve self-care behaviors and quality of life in patients with HF. The results indicated that HeartMapp can improve several clinical outcomes for patients with HF, such as reducing pitting edema and decreasing hospitalization (Riegel et al., 2017). Similarly, another study comparing HF patients who received the standard treatment to those who received care via a weekly mobile helpline found that the latter achieved enhanced functional capacity and fewer symptoms (Beratarrechea et al., 2014), such as, for example reduced pitting edema, improved dyspnea control, and fewer physical deficiencies (Beratarrechea et al., 2014).

**Fourth Hypothesis**

The researcher hypothesized that Thai patients with HF who use the HFAA will demonstrate lower hospital readmission rates compared to those who do not use the mobile app. When comparing the hospital readmission rates measured at Day 90 between the two groups, significant differences were found (p<.05). As hypothesized, the intervention group had fewer hospital readmissions than the control group.

This hypothesis was proposed because the HFAA encourages patients to adjust their medications and fluid intake, and provides daily warnings and health information. Such measures can lead to decreased readmissions (Widmer et al., 2015).

Many studies support the hypothesis that mobile apps can reduce re-hospitalizations and improve health outcomes. Widmer et al. (2015) stated that mobile apps enhance self-management and self-care behavior, which lead to significant improvements in systolic BP,
weight, lipids, and exercise capacity, decreasing the need for re-hospitalization as well.

Likewise, Vuorinen et al., (2014) indicated that mobile apps have immense potential in supporting patients with self-management, increasing quality of life, and improving clinical outcomes. In contrast, patients who received the standard treatment had poor self-management, leading to high mortality and hospital readmission rates. A pilot study compared the length of stay and re-hospitalizations between older HF patients using MedSentry, a mobile app, and those receiving the standard treatment (Hale et al., 2016). The study found significant decreases in both variables among those who used MedSentry (Hale et al., 2016). As in another previous study, Kitsiou, Paré, and Jaana (2015) found that patients who used a mobile health intervention required fewer hospitalizations due to HF, compared to those who received the standard treatment (0.64 vs. 0.86). They conducted multiple systematic reviews on the effectiveness of telemonitoring interventions for patients with HF, reporting that many studies found mobile telemonitoring to reduce hospitalizations by 28% \((p>0.05)\) (Kitsiou et al., 2015). All these findings indicate that mobile apps have so far provided more effective services that improve clinical outcomes for patients with HF.

**Limitations**

The present study has several limitations that must be acknowledged. First, the intervention period was limited to three months, which may be inadequate for determining the intervention’s long-term, physical effects on the ongoing management of HF. While previous studies of longer duration have shown that there is a problem of subject dropout (Stut et al., 2015), considerations should be made toward extending the research period to a longer term, such as six or twelve months, to further assess the clinical and functional outcomes of patients with HF.
Second, the HFAA can only assist patients with calculating and adjusting diuretic dosages, not multiple medications. A study using a mobile application that can effectively track medication adherence is required. However, this is challenging because no devices exist that can easily track multiple prescriptions, which is the case for most patients with HF.

Third, even though this study excluded patients who had cognitive impairments, some patients with HF failed to properly use the mobile Internet browser. This problem was solved by the facilitator, researcher, and healthcare team visiting the patients’ homes to reinstall the app and teaching them how to use the mobile phone’s Internet browser. Moreover, some subjects’ phones carried an older version of Android, although the HFAA required at least version 5.0 to run. This issue was solved by updating the mobile version before installing the application.

Fourth, as this study was only conducted in Thailand, its results cannot be applied to other countries.

**Conclusions**

Self-management is a patient skill used to manage symptoms, monitor health conditions, and maintain a positive health status. Lorig and Holman (2003) argued that “successful self-management is driven by patient-defined problems and fosters the mastery of skills in problem solving, action planning, decision making, and support building through an iterative process” (p. 265). Ongoing self-management is key to preventing adverse health outcomes (Plow et al., 2016). Mobile phone applications have paved the way for the efficient storing and retrieval of a wealth of health information. Patients who use mobile apps can access their health information, monitor their conditions, make appropriate decisions, and collaborate with their healthcare providers to improve their self-management and health outcomes (Lähdesmäki, 2015). The present study shows that HF patients who used the HFAA had lower readmission rates, walked
farther during the 6MWT, and had fewer episodes of pitting edema than patients who received the standard treatment.

Mobile applications are useful for promoting self-management because they provide a non-invasive method to assist patients with their healthcare. The present study demonstrated the feasibility and effectiveness of using an Android application, the HFAA, to enhance self-management in patients with HF. Self-management was measured through the subjects’ readmission rates and physical functions, such as the 6MWT, pitting-edema scores, and blood pressure. As the results show, patients with HF who received the HFAA had lower readmission rates, fewer episodes of pitting edema, and better scores on the 6MWT than those who received the standard treatment. These findings indicate there is strong potential in the HFAA’s features, including its ease of use, ability to accurately calculate and adjust diuretic dosages based on the individual’s prescription and daily health reports, and real-time reminders about the life-threatening signs of HF through automated messages and advice from a healthcare team familiar with the patient’s medical history. The HFAA also allows patients to monitor their weight, assess their heart condition, and access educational information on HF. Patients are reminded to check their weight and answer a set of questions about their symptoms each morning, which results in improved clinical outcomes. Overall, the HFAA was found to support self-management in Thai patients with HF and help healthcare providers in track their health outcomes.

**Implications for Nursing and Health Promotion**

The improved physical function and decreased re-hospitalizations rates found in the present study have implications for nursing practice and education, and for research and theories on health promotion.
Practical Implications

The results demonstrated that the HFAA is an important facilitator in enhancing self-management among patients with HF, including the six skills that are critical to effective self-management: “problem solving,” “decision making,” “resource utilization,” “formation of a patient–provider partnership,” “action planning,” and “self-tailoring” (Lorig & Holman, 2003, p. 1-6). The HFAA made a difference in HF patient outcomes while demonstrating that nurses can tailor and manage healthcare for each patient through the HFAA. This study also indicated the importance of enhancing self-management skills via HFAA, as it is suitable for patients with low literacy. Last, this study showed that the HFAA can encourage greater participation from patients in the medical decision-making process, thereby empowering patients with HF.

This study is important for healthcare providers who are concerned about patients with acute decompensated HF and who require more appropriate methods to address disparities in healthcare provision, especially for patients located in remote areas. HF patients with inadequate self-management skills experience difficulties in improving their physical functions and are frequently re-hospitalized. This study implies that nurses can use the HFAA to collaborate with HF patients in setting and meeting their healthcare goals.

Educational Implications

The present study fills gaps in the knowledge and understanding of the SMCI theory used with mobile technology. This information offered an innovative teaching strategy for integrating mobile technologies into the nursing curriculum such as using mobile technology to educate patients with heart failure, analyzing the self-management theory within the context of technology and nursing practices. Additionally, HFAA could educate patients on their individual plan of care continuously and improve quality of care for these patients.
Research and Theoretical Implications

The present study revealed that age and educational level did not reach statistical significance within the analysis. This suggests that these factors are irrelevant to the HFAA’s use. This finding indicates that older patients can use the HFAA application to enhance their self-management behaviors or solve the problems. This application can also engage the heart failure patients without setting a minimum education level requirement. In addition, long-term research is required to determine the exact benefits offered by the HFAA to patient outcomes.

Clinical Implication

HFAA assisted patients to monitor their symptoms, promoted patient engagement in self-care, and provided interactive communication with health care providers. The healthcare providers could access the data in real-time to improve the decision-making ability and clinical management. With regard to the shared information, the HFAA offers a robust source for the healthcare organization to evaluate their clinical outcomes. Therefore, mobile applications are a critical device to support successful self-care management and improve clinical outcomes.

The results were found to support the SMCI theory, as the HF patients in the intervention group could walk farther during the 6MWT at Day 90, compared to their baseline measurements, and exhibited fewer episodes of pitting edema and decreased readmission rates than those who received the standard treatment (i.e., the control group). Further investigations are needed on the potential for self-management, particularly decision making, in modifying other variables thought to be associated with physical function and readmission rates. Although the HFAA has been found to be useful in the present research, further clarifications of the six self-management skills could lead to a more harmonious theoretical model for predicting and explaining self-management.
Recommendations for Future Research

Based on the results of the present study, the following themes are suggested for future research:

1. Evaluating cost effectiveness of mobile phone applications, which will help policymakers perform practical decision making;

2. Comparisons of the effectiveness of mobile application between the present findings and results from different populations;

3. Long-term studies evaluating the impact of mobile applications on HF care and self-management over 12 months;

4. Improve the mobile app’s function with different functionalities parallel to the existing ones such as individualized physical activity, dietary and multiple medication monitoring;

5. Mobile apps that can be installed on older versions of Android and are easily downloaded onto individual devices; and

6. Mobile apps that are projected to continue to develop, bringing enhanced profits to clinical practices and enabling even larger databases to be built.

Chapter Summary

This chapter discussed the implication of research finding. The Self-management in Chronic Illness (SMCI) theory, by Lorig and Holman (2003), was integrated into this study to determine the effect of the intervention on the dependent variables: the 6MWT scores, systolic and diastolic BP, episodes of pitting edema, and re-hospitalizations due to HF. Implications for nursing practices and education, implications for research and theory, recommendations for future research, and conclusions were also presented.
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APPENDIXES

APPENDIX A

Consent to Participate in a Research Study for Intervention group
**Name of Study:** The Feasibility of the Heart Failure Mobile Phone Aide Application (android apps.) on Self-Management Measured by Improved Physical Function and Reduced Hospital Admissions related to Heart Failure (In Thailand).

**Investigator:** Chittraphorn Suthipong, PhD candidate, MSN, RN

E-mail: 19suthipong@cua.edu

Supervisor: Teresa Walsh, PhD, MSN, RN, NE-BC

E-mail: Walsht@cua.edu

**Description and Purpose of the Study:** I understand that I am being asked to participate in a research study examining the effects of the Heart Failure Mobile Phone Aide Application (mobile apps.) on patient self-management among patients with heart failure in Thailand. The completion of this research is in partial fulfillment of the requirements for Doctor of Philosophy degree at The Catholic University of America.

**Procedures:** I understand that I will use the HFAA for approximately 3 months in order to complete this research study. I understand that the research study consists of: (a) discharge planning education by a registered nurse at the heart failure clinic in the facility hospital, (b) recording of electronic weigh-ins, (c) recording of digital blood pressures, (d) receiving and installing the HFAA application on my mobile device, (e) training how to use the HFAA for 1and 1/2 hour in HF clinic, (f) participating in the Six-Minute Walk test (6MWT) twice, at
the beginning of the study and at the end (three months later), (g) measurement of hospital re-
admission rates after 3 months, (h) Blood pressure (BP) and pitting edema measurements will
be averaged at baseline, 30, 60 and 90 day.

**Benefits that may occur:** I understand that the research study may help me by increasing my
self-management skills and decreasing my chances of hospital readmission. Risks,
inconveniences, and/or discomforts may arise. I understand that participation in this research
study is completely voluntary. I understand that I may also be inconvenienced by the amount
of time it may take for me to notate and input the required health readings and other
information into the HFFA, as well as complete all patient questionnaires.

**Right to Withdraw:** I understand that I have the right to withdraw from the study at any
time, for any reason. In the event I choose to withdraw from the study all information I have
provided will be destroyed and omitted from the study, and it will in no way affect the
medical care I receive from the hospital.

**Confidentially of research records:** I understand that all information I give will be kept
confidential. I will not be identified by name with any of the information obtained and that
any sharing of information obtained in this study will be only in the form of group summaries
of all participants. The research study outcomes will be kept on a protected computer-server
at The Catholic University of America. When downloaded for data analyses, printed hard
copies of the data will be saved in a secure, locked location. All code books will be destroyed following data analyses. I understand that my research records, like hospital records, are protected under HIPPA.

Because the researcher has provided contact information, I have had an opportunity to ask questions and consult about the research study and my participation in it. I either chose not to contact the researcher prior to my participation in the study, or I have contacted the researcher, and all my questions have been answered to my satisfaction.

__________________________________________  ____________________________________________
Participant’s Signature                        Researcher’s Signature

__________________________________________  ____________________________________________
Date                                         Date

Any complaints or comments about your participation in this research project should be directed to the Secretary, Committee for the Protection of Human Subjects, Office of Sponsored Programs and Research Services, Chiangrai Prachnukroh Hospital, Tel.053-711 300
APPENDIX B

Consent to Participate in a Research Study for control group
Name of Study: The Feasibility of the Heart Failure Mobile Phone Aide Application (android apps.) on Self-Management Measured by Improved Physical Function and Reduced Hospital Admissions related to Heart Failure (In Thailand)

Investigator: Chitraphorn Suthipong, PhD candidate, MSN, RN
E-mail: 19suthipong@cua.edu

Supervisor: Teresa Walsh, PhD, MSN, RN, NE-BC
E-mail: Walsht@cua.edu

Description and Purpose of the Study: I understand that I am being asked to participate in a research study examining the effects of the Heart Failure Mobile Phone Aide Application (mobile apps.) on patient self-management among patients with heart failure in Thailand. The completion of this research is in partial fulfillment of the requirements for Doctor of Philosophy degree at The Catholic University of America.

Procedures: I understand that this research study will take approximately 3 months to complete. I understand that the research study consists of: (a) I will receive discharge planning education by a registered nurse at heart failure clinic in the facility hospital and (b)
I will complete the Six-Minute Walk test (6MWT), to measure the differences in my physical burden baseline after 3 months. Hospital readmission rates will also be measured at 3 months, blood pressure (BP) and pitting edema measurements will be averaged at 30, 60 and 90 day.

**Benefits that may occur:** I understand that the research study may help me by increasing my self-management skills and decreasing my chances of hospital readmission. Risks, inconveniences, and/or discomforts may arise. I understand that participation in this research study is completely voluntary. I understand that I may also be inconvenienced by the amount of time it may take for me to notate the required health readings and other information, as well as complete all patient questionnaires.

**Right to Withdraw:** I understand that I have the right to withdraw from the study at any time, for any reason. In the event I choose to withdraw from the study all information I have provided will be destroyed and omitted from the study, and it will in no way affect the medical care I receive from the hospital.

**Confidentiality of research records:** I understand that all information I give will be kept confidential. I will not be identified by name with any of the information obtained and that any sharing of information obtained in this study will be only in the form of group summaries of all participants. The research study outcomes will be kept on a protected computer-server at The Catholic University of America. When downloaded for data analyses, printed hard copies of the data will be saved in a secure, locked location. All code books will be destroyed following data
analyses. I understand that my research records, like hospital records, are protected under HIPPA.

Because the researcher has provided contact information, I have had an opportunity to ask questions and consult about the research study and my participation in it. I either chose not to contact the researcher prior to my participation in the study, or I have contacted the researcher, and all my questions have been answered to my satisfaction.

Participant’s Signature                                      Researcher’s Signature

Date                                                  Date

Any complaints or comments about your participation in this research project should be directed to the Secretary, Committee for the Protection of Human Subjects, Office of Sponsored Programs and Research Services, Chiangrai Prachukroh Hospital, Tell. 053-711 300
APPENDIX C
Demographic Form

Participant number______

1. Gender:
   (  ) Male        (  ) Female

2. Age______

3. Race:
   (  ) Buddhism
   (  ) Islamic
   (  ) Christian
   (  ) Others__________________

4. Marital status:
   (  ) Never been married (  ) Married (  ) Separated
   (  ) Divorced          (  ) Widowed (  ) other ________________

5. Education level:
   (  ) Never attended school (  ) Less than high school
   (  ) High school graduate (includes equivalency) (  ) Bachelor's degree
   (  ) Master degree        (  ) Ph.D.

6. Occupational
   (  ) Unemployed       (  ) Own business
   (  ) Employee         (  ) Gove


Agriculture ( )
Retired ( )
Others: _____________

7. What was your total household income last year?

Lower than 2,000 Baht ( )
5.001 – 10,000 Baht ( )
2,001-5,000 Baht ( )
Over 10,000 Baht ( )

8. Etiology of heart failure

Valvular disease: _________________________
IHD (ischemic cardiomyopathy) ( )
others: _________________

9. Prescription medications

<table>
<thead>
<tr>
<th>Prescription medications</th>
<th>Route / Dosage / Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE inhibitors/ARB</td>
<td></td>
</tr>
<tr>
<td>Beta-blockers</td>
<td></td>
</tr>
<tr>
<td>Diuretics</td>
<td></td>
</tr>
<tr>
<td>Aldosterone antagonist</td>
<td></td>
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<tr>
<td>Digoxin</td>
<td></td>
</tr>
<tr>
<td>Anticoagulants</td>
<td></td>
</tr>
<tr>
<td>Hydralazine/nitrates</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

“Mini – Mental State Examination: Thai version (MMSE – Thai 2002)”

“แบบทดสอบสภาพสมองเบื้องต้นฉบับภาษาไทย”

The permission to use MMSE-Thai version was granted by the authors and no cost.”

“Orientation for time”

วันนี้วันที่เท่าไหร่ (What is today’s date?)

วันนี้วันอะไร (What day is today?)

เดือนนี้เดือนอะไร (What is this month?)

ปีนี้ปีอะไร (What is this year?)

ฤดูนี้ฤดูอะไร (What is this season?)

“Orientation for place (at home)”

สถานที่ตรงนี้เรียกว่าอะไร และบ้านเลขที่เท่าไหร่ (Where is this place and what is the address?)

ที่นี่หมู่บ้าน ถนนอะไร (What is the name of this village and the name of the street?)

ที่นี่อยู่ในเขต / อำเภออะไร (What is the name of this district?)

ที่นี่จังหวัดอะไร (What is the name of this province?)

ที่นี่ภาคอะไร (What do I call this region?)
“Registration”

“บอกชื่อของ 3 อย่างแล้ว ให้ผู้ถูกทดสอบพูดตาม” (Mention three items then ask the subject to repeat them)

- “ดอกไม้” (Flower)
- “แม่น้ำ” (River)
- “รถไฟ” (Train)

“In case the subject is re-tested within 2 months, the following items will be mentioned)

- “ต้นไม้” (Tree)
- “ทะเล” (Sea)
- “รถยนต์” (Car)

“Attention/Calculation”

“คิดเลขในใจให้เอา 100 ลบออกทีละ 7 ไปเรื่อยๆ ได้ผลลัพธ์เท่าไหร่”

(Ask the subject to conduct the mental calculation: keep subtracting 7 from 100, and each of the results)

........... ........... ........... ........... ...........
สะกดคำว่ามะนาวให้ฟังแล้วให้ผู้ทดสอบสะกดหลังจากพยัญชนะตัวหลังไปตัวแรก

(Spell the words lemon (ma-nao) for the subject and ask her/him to spell the word backward)

“มอม้า-สะระ-น้อ-สะระ-วอนนะ”

Recall

“เมื่อสักครู่ที่ให้จ่าของสามอย่างยังจ่าได้ไหม มีอะไรบ้าง” (Ask the subject to repeat the three items mentioned earlier)

○ “ดอกไม้” (Flower)

○ “แม่น้ำ” (River)

○ “รถไฟ” (Train)

“ในกรณีที่ทดสอบซ้ำภายใน 2 เดือน ให้ใช้คำว่า” (In case the subject is re-tested within 2 months, ask the subject to repeat the following items)

○ “ต้นไม้” (Tree)

○ “ทะเล” (Sea)

○ “รถยนต์” (Car)

Naming
“ยื่นดินสอให้ผู้ถูกทดสอบและถามว่า” (Show the subject a pencil and ask her/him to name it)

“ของสิ่งนี้เรียกว่าอะไร” (What is this thing?)

“ชี้นาฬิกาข้อมือให้ผู้ถูกทดสอบดูและถามว่า” (Show the subject a watch and ask her/him to name it)

“ของสิ่งนี้เรียกว่าอะไร” (What is this thing?)

“Repetition”

“พูดข้อความแล้วให้ฟังทุกคำโดยบอกเพียงครั้งเดียว” (Mention a tongue twist phrase, only once, and ask the subject to repeat it)

“ใครใคร่ขายไก่ไข่”

“Verbal command”

“ส่งกระดาษเปล่าขนาดประมาณ A4 ไม่มีรอยพับ ให้ผู้ถูกทดสอบ บอกผู้ถูกทดสอบว่าจะส่งกระดาษให้แล้วให้รับด้วยมือขวา พับครึ่งกระดาษด้วยมือ 2 ข้าง แล้ววางไว้ที่ ........ (พื้น, โต๊ะ)”

(Hand the subject a piece of paper; ask her/him to take the paper with her/his right hand and fold it in half with her/his both hands then place it on the floor/table)

  o “รับด้วยมือขวา” (The subject take a piece of paper with her/his right hand)
  o “พับครึ่ง” (The subject fold the paper in half)
  o “วางไว้ที่ (พื้น, โต๊ะ)” (The subject place the paper on the floor/table)

“Written command”
“ให้ผู้ถูกทดสอบอ่านข้อความที่กำหนดแล้วให้ทำตาม (จะอ่านในใจหรืออ่านออกเสียงก็ได้)” (Ask the subject to read the written command and take action as instructed)

“ผู้ทดสอบแสดงกระดาษที่เขียนว่า “หลับตา”” (Show the subject a paper with the command “close your eyes) 

⁠‌ ○ “หลับตาได้” (The subject close her/his eyes)

“Writing”

“ให้ผู้ถูกทดสอบเขียนข้อความอะไรก็ได้ ที่อ่านแล้วรู้เรื่อง หรือ มีความหมายมา 1 ประโยค” (Ask the subject to write any complete sentence as they wish) 

........................................................................................................................................................................................................................................

⁠‌ ○ “ประโยคถึงความหมาย” (The sentence is complete and understandable)

“Visuoconstruction”

“ข้อนี้เป็นคำสั่ง “ให้วาดภาพเหมือนภาพตัวอย่าง” (Ask the subject to draw a picture as the sample picture) 

........................................................................................................................................................................................................................................
<table>
<thead>
<tr>
<th>Levels of education</th>
<th>“จุดตัด”</th>
<th>“คะแนนเต็ม”</th>
</tr>
</thead>
<tbody>
<tr>
<td>“ไม่ได้เรียนหนังสือ - อ่านไม่ออก” (Illiterate)</td>
<td>“≥14”</td>
<td>“23”</td>
</tr>
<tr>
<td>(ไม่ต้องทำข้อ 4, 9, 10) (Skip No.4, 9, 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“เรียนระดับประถมศึกษา” (Primary school graduate)</td>
<td>“≥17”</td>
<td>“30”</td>
</tr>
<tr>
<td>“เรียนระดับสูงกว่าประถมศึกษา” (Higher than primary school graduate)</td>
<td>“≥22”</td>
<td>“30”</td>
</tr>
</tbody>
</table>

APPENDIX E

(Guidelines for the Six-minute Walk Test)

“Guidelines for the Six-minute Walk Test (6MWT)”

“This guide is based on guidelines for the 6MWT that is publicly permitted and issued by the American Thoracic Society (Am J Respir Crit Care Med. 2002 Jul 1; 166(1):111-7).”

“Identifying a space for the 6MWT”

- “The same space/corridor should be used for each assessment.”

- “The space should have a level floor (i.e. no steps or slopes) and be straight (i.e. no corners).”

- “The space should have no obstacles (doors, chairs, people etc.)”

- “Ideally, the walking course should be 30 metres long so that 1 lap is 60 metres. This will keep the distance consistent across the participating hospitals and standardise the number of turns required. If a 30 metre space isn’t available, this can be compromised and you can still perform the 6MWT for the STOP-ACEi trial. Please contact the STOP-ACEi trial office at BCTU if the walking course will be a different length.”

- “The space should be quiet enough for the participant to clearly hear your instructions.”

- “Any clocks or timers should not be visible to the participant while the test is being conducted.”
• “You will need to pre-measure the walking distance. The turning points at either end should be marked e.g. with a cone or stationary IV pole. If it’s possible to do so, marking intervals (e.g. every 3 metres) will help you count any partially completed laps.”

• “When initially setting up the area for the 6MWT, be as accurate as possible with your measurements.”

• “A chair should be available for the participant to rest if they are struggling with the test or for after the test has been completed. Also see safety considerations below.”

• “There should be easy access to a telephone and appropriate equipment in case of an emergency, e.g. resuscitation trolley, oxygen, BP machine. Please consider the requirements of your patient population and prepare appropriately.”

“Equipment”

• “A 30 metre level, straight corridor with no obstructions to perform the test in (see above).”

• “Cones (or similar) to mark the turning points at either end.”

• “Stopwatch or timer.”

• “Lap counter (or you can just tick these off on a sheet of paper).”

• “Worksheet, casenotes or paper CRF to record the results on (the source data).”

• “A pen”

• “A chair that can be easily moved along the walking course.”
• “Measuring tape”

“Before the test”

• “It is a good idea to warn the participant that they will be doing the 6MWT ahead of an upcoming trial assessment. They should wear comfortable clothing and appropriate footwear and should continue with their normal medical treatments as usual. The participant should also have any of their normal medications with them (e.g. inhalers, GTN spray etc.).”

• “Make sure the area is prepared and you have all the equipment required (see Identifying a space for the 6MWT above).”

• “Consider whether the 6MWT is clinically appropriate for the participant (see Safety Considerations).”

“Performing the 6MWT”

1. “Set the timer to 6 minutes.”

2. “Prepare any other materials (cones, worksheets, chair etc.) and go to the test area.”

3. “Prepare the participant for the test by giving the following instructions. Please don’t deviate from this script so that all participants have had the same information. This text has been approved by the ATS following consensus conference.”

“The object of this test is to walk as far as possible for 6 minutes. You will walk back and forth in this hallway. Six minutes is a long time to walk, so you will be exerting yourself. You will probably get out of breath or become tired. You are permitted to slow down, to stop, and to rest as necessary. You may lean against the wall while resting, but resume walking as soon as you are able. You will be walking back and forth around
the cones (or poles). You should walk around the cones (or poles) and continue back the other way without hesitation. Now I’m going to show you. Please watch the way I turn without hesitation.”

“Demonstrate by walking one lap yourself.”

“Are you ready to do that? I am going to keep track of the number of laps you complete. I will mark on the worksheet each time you turn around at this starting line. Remember that the object is to walk AS FAR AS POSSIBLE for 6 minutes, but don’t run or jog.”

“Position the participant at the starting line.”

“Start now, or whenever you are ready.”

4. “Start the timer as soon as the participant starts walking.”

5. Keep track of the laps by marking on the worksheet.”

6. “During the test, use the following script:”

<table>
<thead>
<tr>
<th>“5 minutes remaining”</th>
<th>“You are doing well. You have 5 minutes to go”.</th>
</tr>
</thead>
<tbody>
<tr>
<td>“4 minutes remaining”</td>
<td>“Keep up the good work. You have 4 minutes to go”.</td>
</tr>
<tr>
<td>“3 minutes remaining”</td>
<td>“You are doing well. You are half way done”.</td>
</tr>
<tr>
<td>“2 minutes remaining”</td>
<td>“Keep up the good work. You have only 2 minutes left”.</td>
</tr>
<tr>
<td>“1 minutes remaining”</td>
<td>“You are doing well. You have only 1 minute to go”.</td>
</tr>
<tr>
<td>“15 seconds remaining”</td>
<td>“In a moment I’m going to tell you to stop. When I do, just stop right where you are and I will come to you.”</td>
</tr>
<tr>
<td>“After 6 minutes”</td>
<td>Say “Stop!”</td>
</tr>
</tbody>
</table>
(when the timer rings)" | Walk over to the patient. Consider taking the chair if they look tired. Mark the spot where they stopped using a piece of tape on the floor or similar.”

“If the participant stops walking during the test, say “You can lean against the wall if you would like; then continue walking whenever you feel able.” Do not stop the timer. If the participant stops before the 6 minutes are up and refuses to continue (or you decide that they should not continue), take the chair over for them to sit on, discontinue the walk, and note on the worksheet the distance, the time stopped, and the reason for stopping prematurely. If the participant decides to sit on the chair, the test is stopped.”

7. “Record the number of laps on the counter (or tick marks on your worksheet).”

8. “Record the additional distance covered from the final partial lap.”

9. “Calculate the total distance walked and round to the nearest metre. Record this in the participant’s source data and on the STOP-ACEi CRF.”

10. “Congratulate the participant on a good effort and offer them some water”

“**Dos and Don’ts**”

- “Do keep to the script above when verbally encouraging the participant.”
- “Do use an even tone of voice when instructing or encouraging the participant.”
- “Do watch the participant closely while they perform the test.”
- “Do focus and avoid losing count of the laps.”
• “Do ensure the area is free from obstacles/trip hazards before performing the test.”
• “Don’t physically assist the participant during the test.”
• “Don’t use words or body language to speed up the participant. They should set their own pace.”
• “Don’t walk alongside the participant. Stay near the starting line during the test.”
• “Don’t allow any observers (family members etc.) to encourage or walk alongside the participant.”
• “Don’t use an area that is likely to be unavailable for some trial visits.”
• “Don’t talk to anyone else during the test.”
• “Don’t perform practice tests with the participant. This will affect the results of the second ‘real’ test.”

“Safety Considerations”

• “Contraindications: The ATS guidelines state: Absolute contraindications for the 6MWT include the following: unstable angina during the previous month and myocardial infarction during the previous month. Relative contraindications include a resting heart rate of more than 120, a systolic blood pressure of more than 180 mmHg, and a diastolic blood pressure of more than 100 mmHg.”
• “Consider monitoring BP before and after the test. NB this is not required for STOP-ACEi, but may be sensible clinical monitoring for some patients.”
• “Testing should be performed in a location where a rapid, appropriate response to an emergency is possible. A telephone or other means to call for help should be easily accessible.”
• “The person administering the test should be trained in basic life support and supporting colleagues should be easily reachable in case of an emergency. Ideally, 2 people will administer the test.”

• “A chair should be within easy reach for the participant while they perform the test.”

“Questions and Answers”

“Should the 6MWT be performed for all participants?” A reasonable effort should be made to perform the test for all participants. However, if the responsible clinician feels the test is inappropriate or unsafe for any particular participants, the decision to perform the test is at their discretion. There is guidance on specific medical conditions in the ATS guidelines (also see safety considerations above). If a participant is unable to complete the 6MWT, they are still able to continue their participation in the STOP-ACEi trial.”

“When should the 6MWT be performed?”

“The 6MWT should be performed at each annual visit (i.e. at baseline and the 12, 24 and 36 month visits). The 6MWT is a trial procedure and should not be performed before the participant has provided written informed consent.”

“When in the study visit should the 6MWT be performed?”

“The test can be performed at any point during the visit, when it is most convenient for the participant and research team. The participant should be at rest for measurement of blood pressure and the ECG so it might be more convenient to perform the 6MWT after these assessments to avoid any interference.”

“Should a participant use their normal walking aids during the 6MWT?”
“If a participant would normally walk with an aid (e.g. cane, walking frame etc.), they should use this equipment during the test.”

“Can a participant use a GTN spray / oxygen / other medication during the 6MWT?”

“If a participant normally uses a GTN spray (glyceryl trinitrate), chronic oxygen or any other inhalers/medications, the participant should have these with them for the 6MWT and any medications should be used as normal during the 6MWT. In case of any clinical concern or emergency, standard clinical practice should be followed for use of any medications.”

Retrieved from: http://www.birmingham.ac.uk/Documents/college-mds/trials/bctu/STOPACEi/GL-6MWT-v1-0.pdf

Letter of Permission to use Six Minute Walk Test

AMERICAN THORACIC SOCIETY

25 Broadway

New York, NY 10004

United States of America

Phone: +1 (212) 315-8600

Fax: +1 (212) 315-6498

Email: ATSInfo@Thoracic.org

(Judy Corn, Director, Documents & Patient Education 11/28/16)
APPENDIX F

THE CATHOLIC UNIVERSITY OF AMERICA
Office of Sponsored Programs and Research Services
Washington, DC 20064
202-319-5218

May 5, 2017

Mr. Chitrathorn Suthipong
1401 Blair Mill Road, Apt. 1401
Silver Spring, MD 20910

Subject: Project title “The Feasibility of the Heart Failure Mobile Phone Aide Application (Android Apps.) on Self-management Measured by Improved Physical Function and Reduced Hospital Admissions Related to Heart Failure in Thailand” Protocol No. 17-028

Dear Mr. Suthipong:

Your research for the subject project was certified by the Committee for the Protection of Human Subjects (CPHS) as meeting the requirements of the Federal regulations governing protection of human subjects.

CPHS will maintain a copy of your submission on file. You are obligated to follow the research protocol and procedures for obtaining informed consent as you have specified. If you wish to initiate any changes in the research protocol or the informed consent procedure, you should submit this request to CPHS in writing.

The protocol is approved, and expires 11/21/17. The protocol is currently approved by the IRB at the host institution (Chiangrai Prachanukroh Hospital (CPH), approved 12/14/16). This protocol is approved by the CUA IRB contingent upon continued approval by CPH. Should CPH approval lapse or expire, CUA approval is revoked. Investigator must use the approved consent forms from the recruitment site.

Sincerely,

Ralph Albano
Secretary
Committee for the Protection of Human Subjects

cc: [ ] Dr. Walsh

17-028 ARP 04/25/17
[028]
APPENDIX G

IRB

The Internal Ethical Committee for Research in Human Subject
Chiangrai Prachanukroh Hospital

Title of Project: The Feasibility of the Heart Failure Mobile Phone Aide Application (android apps.) On Self-Management, Measured By Improved Physical Function and Reduced Hospital Readmission Rates, among Patients with Heart Failure in Thailand

Principle Investigator: Chitrathorn Suthipong
Institute: Mae Fah Luang University.

The Internal Ethical Committee for Research in Human Subject, Chiangrai Prachanukroh Hospital in ICH-GCP and ethical concern, reviewed the protocol and approved for implementation of the research mentioned above. Therefore Thai version of the protocol will be mainly conducted.

Duration of approval: November 23, 2016 - November 22, 2017

Issued date: December 14, 2016

Chairman, Internal Ethical Committee

Director in charge, Chiangrai Prachanukroh Hospital
All approved investigators must comply with the following conditions:

1. Strictly conduct the research as required by the protocol;
2. Use only the information sheet, consent form (and recruitment materials, if any), interview outlines and/or questionnaires bearing the Institutional Review Board’s seal of approval; and return one copy of such documents of the first subject recruited to the Research Ethics Committee (REC) for the record;
3. Report to the Institutional Review Board any serious adverse event or any changes in the research activity within five working days;
4. Provide reports to the Research Ethics Committee concerning the progress of the research upon the specified period of time or when requested;
5. If the study cannot be finished within the expiry date of the approval certificate, the investigator is obliged to reapply for approval at least one month before the date of expiration.
6. All the above approved documents are expired on the same date of the previously approved protocol

*A list of the Research Ethics Committee members (names and positions) present at the meeting of The Research Ethics Committee on the date of approval of this study has been attached. All approved documents will be forwarded to the principal investigator
APPENDIX H

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(Official Emblem)
RorLorKhor.01 Document Registration No. Wor1, 6809

Document Inform certificate
Copyright
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Mrs. Chitrathorn Suthipong

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Name of the work: HEART FAILURE AIDE APPLICATION
(ANDROID): (HFAA) Informed Department of Intellectual Property
As the Copyright Document Application No. 359387 On 29 September 2017

Issue Date: 3 October 2017

(Signed) -Signature-(Mr. Suraphoom Tiranan)
Commercial scholar (Professional Level)
Acting Director of Department of Intellectual Property

Addendum: 1. This certificate does not guarantee the copyright ownership.
2. The changes listed above, see the back.

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(Mr. Thanarat Kaenopesh)
Centa-Care Translation Co., Ltd.
Tel. (+65)6333-352191, info@centa-care.com
www.centa-care.com
(Translation)

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www.centa-care.com