The Effect of Gamification on Heart Failure Self Care Maintenance, Symptom Recognition and Self Care Management

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Dedication

To my mother - thank you for your example of love, persistence, discipline, joy in life-long learning, and always striving to be your best self.

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Abstract

Background Heart failure is associated with high morbidity and mortality, as patients undergo treatment and frequent hospitalizations. Heart failure patients and their support person are charged with implementing self-care behaviors to prevent heart failure exacerbations and hospitalizations. Patients often fail to implement these measures, recognize worsening symptoms or act on them when they arise. Gamification, though newer to heart failure, is an innovative avenue that may develop these self-care goals.

Purpose To study the effect of heart failure gamification on heart failure self-care maintenance, symptom recognition and self-care management in patients recently discharged with a heart failure diagnosis.

Methods This study utilized a quantitative quasi-experimental design. The study included patients who were admitted to an inpatient advanced heart failure unit. After traditional heart failure education, patients completed the Heart Failure Coach simulation game. The Self-Care in Heart Failure Index (SCHFI) v. 6.2 was completed by patients immediately after the simulation game while in the hospital, and seven days after discharge. After the game, patient knowledge gaps identified by the Heart Failure Coach game were reviewed, additional education provided, and a satisfaction questionnaire filled out.

Results 107 patients were screened while admitted for heart failure diagnosis on an acute care unit. Twenty patients were enrolled and 17 patients completed the study. One patient died prior to follow up and two were lost to follow up. The mean age was 61.15 years and the sample was mostly Caucasian (75%), male (65%), NYHA class III or IV (95%) and educated at or above the college level (75%). There was a significant increase in self-care maintenance and self-care confidence on the SCHFI ($t = -3.769$ [CI -24.58 - -6.88] $p < .002$ and $t = -4.570$ [CI -25.49 –

-13.67] $p < .001$ respectively). Due to lack of symptoms, follow up SCHFI self-care management scores could not be assessed. Greater than 90% of the patients were satisfied with the Heart Failure Coach in areas self-care maintenance and symptom recognition and more patients (45%) requested additional heart failure education with the Heart Failure Coach versus traditional education methods (15%).

Conclusion Participation by patients admitted with a heart failure diagnosis in gamification with the Heart Failure Coach, showed a positive impact on heart failure self-care maintenance and confidence. Patients reported that the game was easy to use and well liked regardless of age. The Heart Failure Coach game provided a simulated and active learning environment to enact heart failure scenarios independently or with a support person. Further exploration of the use of heart failure gamification to effect self-care behaviors, particularly in symptom recognition and management, should be pursued.

The Effect of Gamification on Heart Failure Self-care Maintenance, Symptom Recognition and Self-care Management

Background and Significance

Heart failure is a chronic and progressive syndrome with increasing prevalence in the United States. Heart failure rates continue to increase, with 800,000 newly diagnosed patients over the past eight years (American Heart Association, 2017). The prevalence of heart failure increases with age, with those over the age of 69 most affected (Turrise, 2016). From 2009-2011 approximately 5.7 million Americans were diagnosed with heart failure, this increased to 6.5 million from 2011-2014 (American Heart Association, 2017). This rate is expected to increase to 8.1 million people by 2030 (Centers for Disease Control and Preventions, 2017) due to the aging population, comorbidities of diabetes and obesity, as well as better survival of those patients who suffer myocardial infarction (American Heart Association News, 2017).

The fiscal impact of heart failure is significant. Heart failure is costly, with estimates totaling $30.7 billion annually (Kociol, et al., 2012; Centers for Disease Control and Preventions, 2017), and are projected to increase to $70 billion by the year 2030 (Heidenreich, et. al., 2013). On a human level, there is also the morbidity of hospitalizations and readmissions have on the patients and their families. Despite guidelines in place since 2005, only few hospitals have seen meaningful results (Beergethon, Ju, & Fonarow, 2016).

Transition from hospital to home

One period of vulnerability of heart failure exacerbations is during patients' transition from an inpatient to outpatient setting. The American College of Cardiology and the Institute for Healthcare Improvement collaborated to initiate Hospital to Home in 2009 (Baker, Oliver-McNeil, Deng, Hummel, 2015). A component of this initiative was early post-discharge follow

up to decrease 30-day readmission rates (Baker et al. 2015). Hernandez et al., (2010) conducted a large observational study involving 30,136 patients from 225 hospitals, to review all-cause readmission within 30 days after discharge. While there was significant variation in follow up care for hospitalized heart failure patients, they found that patients discharged from the hospital who had earlier follow up, were at lower risk of 30-day readmission (Hernandez et al., 2010). Baker et al., (2015) in a large observational study of 10 hospitals involving 26,358 patients studied the effect of seven-day post discharge follow up on 30-day readmission rates. The 10 hospitals in the study underwent gap analysis unique to each hospital in an attempt to identify barriers to seven-day follow up visits and decreasing rates of 30-day heart failure readmissions (Baker, et al., 2015). While the study had significant reductions in heart failure 30-day readmissions, there was only moderate improvement in obtaining seven day and even 14 -day follow up care for discharged patients (Baker, et al., 2015).

Symptom Recognition and the role of Patient Education

To address issues of patient morbidity and financial burden to hospitals, significant efforts to improve patient education have been made. Heart failure patients and their caregivers have been charged with the tasks of medication knowledge, awareness of symptoms, seeking help for symptoms or managing their symptoms when troublesome (Riegel, Dickson, and Faulkner, 2016). This process can be described as self-care in heart failure (Riegel, Lee, Dickson, Carlson 2009; Evangelista and Schinnick, 2008). Emphasis has been placed on patient education to help achieve these goals and minimize readmissions with heart failure (Riegel et al., 2016). Patients and their caregivers have traditionally been given written educational materials to reinforce heart failure education; while this has proven helpful in solidifying heart failure knowledge, readmissions rates are the same (Clark, et al., 2015; White, Garbez, Carroll, Brinker,

& Howie-Esquivel, 2013; Dracup et al., 2014; Beergethon, et al., 2016 & Gallagher, 2010). Educational teaching strategies such as teach-back, heart failure diaries, and videos have also been utilized with improvement in patient knowledge levels; however, the rates of readmission have remained virtually unchanged (Clark et al, 2015, White, et al., 2013). More recently, some studies report that while patient and caregiver knowledge level can be adequate, recognizing symptoms and implementing actions to alleviate worsening symptoms are not taken by the heart failure patient (Riegel et al. 2008; Clark, et al., 2012, Clark, et al., 2015; Riegel et al., 2016). Experts assert that this is partly due to age and comorbidities (Jurgens, et al., 2009; 2013; Riegel et al. 2010).

Symptom recognition and appropriate self-care by patients with heart failure is challenging. In a systematic review by Clark et al. (2012), heart failure patients' symptoms were found to be similar to symptoms of other chronic conditions and that patients could not discern acute change. The researchers also found that patients had difficulty accessing a provider to help with symptom assessment and /or management (Clark et al., 2012).

The Role of Heart Failure Gamification

The role of technology has come into play recently with the American College of Cardiology calling for an increased role of digital health in cardiac care to reduce costs and improve outcomes (American College of Cardiology, 2018). In other chronic conditions, like diabetes or asthma, simulation games have successfully been used to reinforce knowledge, assess symptoms, and formalize plans for self-management (Lehmann, DeWolf, Novotny, Reed, & Gotwals, 2014). Little is known regarding the impact of heart failure simulation games on self-care behaviors. Only one study was found that measured the usability and likability of simulation games on outpatient seniors with heart failure (Radhakrishnan et al., 2016a). There is

strong evidence that traditional heart failure education has increased patient knowledge but failed to reduce readmissions (Hernandez and Devore, 2015). The purpose of this study was to determine the effect of heart failure gamification on heart failure self-care maintenance, symptom recognition and self-care management in patients recently discharged with a heart failure diagnosis.

Purpose of the study

Heart failure education is essential for initiation of self-care (Harkness, Spaling, Currie, Strachan, & Clark, 2015; Clark et al., 2015). Symptom recognition and knowing when to seek assistance is an important component of heart failure education. Heart failure patients are often older with diminished neurological or cognitive feedback and experience chronic or comorbid symptoms. This complicates their ability to know when symptoms are serious enough to warrant medical attention (Harkness, et al., 2015; Clark et al., 2015. Clark et al., 2012). Patients often delay seeking care from days to weeks all the while experiencing significant symptomatology (Harkness, et al., 2015; Clark et al., 2015. Clark et al., 2012) .

While simulation games have been used successfully in chronic diseases like diabetes and asthma, little is known regarding the impact of heart failure gamification on self-care management and symptom recognition. Only one study was found that has explored the impact of utilizing simulation on heart failure knowledge and self-management skills (Radhakrishnan et al., 2016). While the results were promising, the patients studied were elderly and community-based patients. The purpose of this study was to determine the effect of heart failure gamification on heart failure self-care maintenance, symptom recognition and self-care management in patients recently discharged with a heart failure diagnosis.

Research Question

What is the effect of participating in a heart failure simulation game, Heart Failure Coach, after traditional education, on self-care maintenance, symptom recognition, self-care management in patients recently discharged with a diagnosis of heart failure?

Review of the Literature

Methodology of integrative review

An integrative review of the literature was conducted on the use of simulation games and heart failure patient education. This review included research from literature synthesis, experimental, quasi-experimental, non-experimental and qualitative studies. A medical librarian was consulted for guidance with key search terms. An extensive search of the literature was completed from April 15, 2018 to May 1, 2018 using the databases of CINAHL, PubMed, Ovid-Medline, Cochrane, Joanna Briggs, PsycINFO, ERIC, American College of Cardiology and Google Scholar.

Search limitations were employed that referenced the PICOT question and study purpose. Few articles were found pertaining specifically to heart failure self-care and gamification. For the purpose of this review, two areas of review were employed. The first review section focused on heart failure self-care and symptom recognition. The second area of review focused on simulation games and heart failure.

Heart Failure Self-care and Symptom Recognition

The search terms used in this integrative review of the literature included heart, heart failure, self-care, self-management, symptom perception, and symptom recognition (Figure 1). Article inclusion criteria consisted of articles published between 2008 – 2018, written in

English, involved adult heart failure subjects, included the use of self-care, self-management, symptom-recognition or perception. Table I was compiled that documented each database explored, noting keywords or Medical Subject Headings (MeSH) terms, the numbers of articles included, articles excluded and their rationale for exclusion, duplicate articles and final article count.

Simulation Games and Heart Failure

The search terms utilized in this integrative review of the literature included cardiovascular disease, heart, heart failure, simulation, simulation game, game, gamification, serious game, video games, chronic disease, patient compliance, medication compliance, self-care, and self-management (Figure 2). Inclusion criteria included publication dates between 2008-2018, written in English, involving adults over 18, use of games or simulation for persons with chronic disease, outcome of benefits of simulation games. Exclusion criteria were non-health related video games, tele-health, tele-monitoring, and remote-monitoring. Table 2 was compiled which documented each database explored, noting keywords or Medical Subject Headings (MeSH) terms, the numbers of articles included, articles excluded and their rationale for exclusion, duplicate articles and final article count.

Findings of Integrative Review

Heart failure self-care and symptom recognition.

In the review of heart failure self-care and symptom recognition, 51 studies were yielded. Seven of the studies were duplicates, with 28 additional studies excluded by title or abstract. This resulted in 16 articles included for further review. Of these 16 articles five were randomized controlled trials (RCT) (Dracup et al., 2014, Clark et al., 2015, Boyde et al., 2017; Jurgens, et al., 2013; & White et al., 2013), two quasi-experimental studies (Gallagher, 2010;

Riegel et al., 2009), five systematic reviews of the literature (Clark et al., 2012; Lam & Smeltzer, 2013; Harkness et al., 2015; Evans, 2016, & Lee and Riegel, 2018), two descriptive studies (Altice and Madigan, 2012; Sethares, Sosa, Fisher, & Riegel, 2014), one prospective study (White, Howie-Esquivel, & Caldwell, 2010), and one retrospective study (Wu, et al., 2017). Historical review was performed and one retrospective study (Evangelista, Dracup & Doering, 2000) and one qualitative study (Reeder, Ercole, Park and Smith, 2015) were also found to be relevant. The findings of the literature search are listed in Table I. The PRISMA diagram of the search process is provided in Figure I.

Heart failure and gamification.

In the review of heart failure and gamification, 203 studies were retrieved. Eight studies were duplicates, and one study was reprinted in a different journal. On further review, 187 of the remaining studies did not meet inclusion criteria. Of the seven studies that remained, one study was an RCT (Heinrich et al., 2012), one quasi-experimental study (Dilles, et al., 2011), two observational studies (Dithmer, et al., 2016; Duplaa, Kaufman, Suave & Renaud, 2017), one systematic review of the literature (Primack et al., 2012), one usability study (Radhakrishnan, 2016) and one feasibility study (Radhakrishnan, 2016a). These study search findings with their results are listed in Table 2 with a Prisma diagram of the search process listed in Figure 2.

Literature Results

Self -management. Heart failure patients and their support persons are asked to perform a series of self-care behaviors to maintain wellness. These behaviors include consistently taking medications, monitoring body weights, dietary sodium and heart failure symptoms (Evangelista and Shinnick, 2008). These behaviors are often new to patients, and frequently involve

significant changes to their previous lifestyle. These behaviors must be done consistently and with an element of reflection to appreciate the impact of the behaviors (Evangelista and Shinnick, 2008). Evangelista and Shinnick (2008) reviewed the literature and found that successful interventions had characteristics that motivate, empower, and encourage patients to make educated choices regarding their care.

Self-management has become a focus of patient care, to decrease hospital readmissions, decrease morbidity and decrease mortality. Since Evangelista and Shinnick's 2008 article, patient education has focused on improving education techniques and enhancing skills that promote self-management. Vincent and Mutsch (2015) recognized the need for improved patient heart failure self-management and called for the nursing community to assist patients with symptoms recognition to prevent deterioration and hospital readmissions. Harkness, et al., (2015) note that while patients often have empiric knowledge of heart failure, translating that knowledge into the actions of symptom recognition and then self-care management often proves elusive. They further found that self-care is unique to each patient, and that self-care behaviors often require behavior modifications patients must engage in to maintain independence and quality of life (Harkness et al., 2015).

In an attempt to respond to the individual needs of heart failure patients, patient need assessments and individualized teaching were employed by Dracup et al. (2014). Dracup et al., (2014) performed a randomized controlled trial involving heart failure patients living in rural areas. Patients were randomized into three groups, control (standard care), Fluid Watchers LITE (included a face to face education sessions on self-care with two follow up phone calls) and Fluid Watchers Plus (a face to face education session with biweekly phone calls until the

patient was deemed adequately trained). At a two year follow up however, there was no significant difference in rates of hospital readmission or cardiac death between the three groups.

The teach-back method has also been employed as a means to improve patient education and promote self-care (White et al., 2013.) White et al. (2013) found that while patients with longer heart failure education sessions had improved retention of information on heart failure teach back questions, 30-day heart failure hospital readmissions were not reduced.

Patient heart failure diaries have also been employed to promote heart failure self-care. White, et al. (2010) utilized diaries as a means of fluid and weight management to determine if consistent recording fluid status and weight monitoring impacted symptom management. The authors found the diaries improved patient adherence to fluid status and weight monitoring, but there was a lag in patients using the information from the diaries to seek medical attention (White, et al., 2010). The authors recommended that providers encourage patients to utilize diary information to assess their symptoms and guide when to seek care (White, et al., 2010).

Patient education has also incorporated the use of DVDs or videos. Vernoff, et al. (2011) employed the use of DVDs in helping to improve self-care knowledge. Vernoff et al. (2011) found that patients that watched a video and received a written education booklet were more likely to participate in daily weights, sodium and fluid restriction; however, other self-care activities revealed no change in behavior. Boyde, et al. (2017) in a randomized controlled trial utilized multimedia approach, which included viewing of DVD, verbal discussion with written literature to further individualize patients' learning needs with teach back. They reported 24 hospital readmissions in the intervention group versus 44 readmissions in the control group at the 12-month time point.

Clark et al. (2015), in a randomized controlled trial studied the effect of a supportive education tool in the home setting with recently discharged elderly heart failure patients. The average age of patients was 62.4 years, and advanced practice nurses delivered the intervention in the home setting. The intervention group showed improvement in self-care outcomes including functional status, self-efficacy, quality of life, metamemory and heart failure knowledge (Clark et al., 2015). Symptom recognition and patient driven seeking of care was not measured however (Clark et al., 2015).

Symptom Recognition. The inability to decrease hospital readmissions and decrease mortality, despite verification of patient knowledge, has often been noted in the literature (Gallagher, et al., 2012). Evangelista, et al. (2000) utilizing a retrospective chart audit studied heart failure exacerbations and delay of presentation for treatment. They found high rates for delay in heart failure treatment, on average 2.93 + 0.68 days, which led to increased length of stay and poorer outcomes (Evangelista, et al., 2000). Evangelista, et al., (2000), called for increased interventions that would improve symptom recognition and outcomes of treatment. Riegel et al. (2010) studied "somatic awareness" as well as symptom recognition. They found a need to study interventions that focus on symptom recognition, particularly in the elderly, to further patients' self-care management efforts. Clark, et al. (2012) performed a qualitative systematic review of 58 studies and found that heart failure treatment seeking was recognized as a part of life with heart failure. Patients found as their symptoms are chronic, it is difficult to assess the significance of their symptoms (Clark et al., 2012). Additionally, accessing clarification of the severity of their symptoms through their health care professionals also proved problematic (Clark et al., 2012).

Sethares, et al. (2014) in a descriptive study of 131 hospitalized heart failure patients found the median time to seek attention for symptoms was 60 hours, with a range of 1 to 336 hours and only 25.9% sought care in less than 12 hours. Waiting to see if symptoms would subside, passive response to symptoms from others, and living in a rural environment were found to be statistically significant as reasons for not seeking treatment (Sethares et al., 2014). Altice and Madigan (2012) utilized the Heart Failure Somatic Perception Scale (HFSPS) to study patients' symptom recognition and care seeking behavior. They found that duration of symptomatology, which could include a combination of symptoms, lasted from five minutes to eight years (Altice and Madigan, 2012). Eighty percent of patients described acute and chronic symptoms, with acute symptoms prompting emergency attention and chronic symptoms prompting proactive attention (Altice and Madigan, 2012). They also found no correlation between HFSPS scores and attention seeking behavior (Altice and Madigan, 2012).

In an integrative review, Lam and Smeltzer (2013) evaluated seven qualitative and seven prospective studies to examine patient reported symptom recognition, patient attempted self-care management and treatment seeking behaviors. The investigators found that dyspnea was the most frequent heart failure symptom with variation in duration and severity, as well as greater challenges in an elderly adult population to identify symptoms and that limited data was available on patient awareness of symptoms and self-management was available (Lam and Smeltzer, 2013). Hoban, Fedor, Reeder, & Chernick, (2013) in an exploratory analysis found that while two thirds of heart failure patients experienced not feeling at their baseline, only 15% of those patients attributed this to their heart failure. Reeder, et al. (2015) went on further to study this phenomenon and found that again 61.7% could identify not feeling well at baseline. Symptoms of dyspnea were present in 85% patients, fatigue was present in 53.3% of

patients, and edema was present in 41.7% of patients. Despite the recognition of these symptoms, patients failed to attribute these symptoms to their heart failure and seek expeditious treatment. Similar findings were reported by Wakefield, Groves, Drwal, Scherubel & Kaboli (2016), who used a monitoring tool for daily weights and dyspnea over a three-month period. While patients were compliant with the tool's use, found the tool helpful and stated they would recommend it, none of the patients reported using the tool to guide management (Wakefield, et al., 2016). Reeder et al., (2015) called for interventions to help with symptom recognition, accurate assessment and following through to expeditious treatment.

Evans (2016) completed an integrative review of literature to assess symptom recognition and healthcare utilization in adult heart failure patients. Length of days with symptoms ranged from two to three days, with reasons for delay in seeking treatment noted to include uncertainty of symptomatology, patient desire to see if symptoms would self-correct and lack of trust in the medical system (Evans, 2016). Additionally, behaviors that prompted utilization of medical care included prompting by a significant other or healthcare provider, greater severity of symptoms, and prior history of myocardial infarction or stroke, and prior presentations for heart failure (Evans, 2016).

Similar findings were found by Wu et al. (2017). In a retrospective study of patients admitted with heart failure exacerbations, Wu et al. evaluated factors that precipitated symptoms, duration of time prior to seeking care after recognition of symptoms, length of stay and co-morbid events. Wu et al. found that patients typically had 5 signs or symptoms before presenting for admission. Ninety three percent of patients noted dyspnea as their most frequent symptom, with 20% of patients presenting, waited till their dyspnea was severe prior to presenting (Wu et al., 2017). Sixteen days was the average length of delay from recognition of

sign or symptom to presenting for treatment (Wu et al., 2017). There was no correlation between length of delay and length of hospitalization (Wu et al., 2017). This length of experience of symptoms prior to seeking medical assistance is significant and could prove helpful in decreasing hospitalization.

Lee and Riegel (2018) in their integrative review of heart failure symptom research found most patients had difficulty with recognizing heart failure symptoms. Factors contributing to lack of awareness were age, comorbidities, and gradual symptom progression (Lee and Riegel, 2018). Factors facilitating symptom recognition included prior hospitalization, living with others, poorer functional status, higher level of education and higher level of uncertainty (Lee and Riegel, 2018).

Gamification. While post hospital discharge technology (e.g. pulmonary impedance technology and tele-management) has been used to help with post discharge symptom and heart failure management, integrating heart failure knowledge and heart failure management prior to hospital discharge has proven more challenging. Technology has begun to answer that call with gamification. Gamification has been described as an "approach to teaching and learning where motivational learning experiences are designed utilizing methods that engage the psychology of human play" (McDougall, A, 2018 p. 469). McDougall (2018) also notes games provide situations that people can solidify knowledge, think of solutions, trial new behaviors or practices, receive feedback on the effectiveness of the choices and hopefully obtain mastery. Primack et al. (2012) performed a systematic review of the literature for the role of video games in improving health-related outcomes; they found the video games were promising in a wide area of healthcare issues across varying socioeconomic groups. Kawachi (2017) notes that gamification is an avenue to promote behavior change that is increasingly being used in health care. Gamification

has been used successfully in diabetes management (Brownson, Hoerger, Fisher, & Kilpatrick, 2009; Lehmann, et al., 2014), and in nutritional behavior (Berger and Schrader, 2016). Miller, Cafazzao and Seto (2016) found that gamification provided a successful implementation for encouraging improved patient self-management.

Charlier et al. (2016) performed a systematic review and meta-analysis on gamification to improve knowledge and self-management in young persons with chronic diseases. Charlier et al. (2016) reviewed nine studies and included seven for analysis. Knowledge was improved in six of the studies and self-management in two (Charlier et al., 2016). Those patients that participated with gamification had significant post-test improvement of knowledge. Duplaa, et al. (2017) developed a questionnaire that studied social and cognitive benefits of seniors that engaged in video games. The investigators studied 590 Canadian seniors and found that non-institutionalized seniors perceived cognitive aspects (attention, memory, response speed, problem solving and reasoning improved in range from 57 to 71% (Duplaa et al., 2017). Social aspects (family, new / existing friends, links with other age groups were also perceived to improve in ranges from 22.7 – 30.8% from gamification (Duplaa et al. 2017).

Simulation games have been utilized in the diabetes self-management for over 15 years (Lehmann, et al., (2014). A downloadable diabetic education and glucose-insulin simulation game, glucose-insulin Action + Insulin dose and Diet Adjustment in diabetes mellitus (AIDA), allows patients to interact in 40 different scenarios to adjust diet, activity and insulin. In 2014, over 637,500 simulations had been accessed on line to reinforce learning and obtain mastery (Lehmann et al., 2014). Heinrich, et al. (2012) performed a randomized controlled trial utilizing Diabetes Interactive Education Program (DIEP). The intervention group was found to have significantly higher post intervention knowledge levels. Eighty five percent of patients found the

information they were seeking and 98% found it user friendly. The study did not focus on self-management but saw this as a future implication of DIEP (Heinrich et al., 2012).

Dilles et al., (2011) studied computer assisted learning versus standard written heart failure educational materials. While the design of the study did not explore superiority, it did find the computer assisted learning was as advantageous as standard education (Dilles et al, 2011). Dithmer et al. (2016) found gamification useful in utilizing "the Heart Game" and cardiac tele-rehabilitation in Denmark. Patients, who often paired with a support person, used the game as a component of their tele-rehabilitation program and reported it as a useful tool in everyday life (Dithmer et.al, 2016). Radhakrishnan et al. (2016) developed a heart failure game to reinforce heart failure education, symptom recognition and management Radhakrishnan et al. (2016) initially performed usability testing and found that in older adults the heart failure game was enjoyable, accepted and an effective means to teach heart failure symptom management to older adults, and particularly with lower education older adults who were a larger part of the study patients . Radhakrishnan et al. (2016a) later went on to complete a feasibility study of a heart failure self-management game with community dwelling older adults. Of the patients in the study, 100% found it easy to play, 100% found it enjoyable, and 83% found it helpful in heart failure education.

Gap in the Literature

No randomized controlled trials of patients utilizing gamification to improve heart failure self-care maintenance, symptom recognition, or self-care management in an inpatient setting were found in the review of literature. Heart failure gamification introduces an interactive component to traditional heart failure education

Theoretical Framework

Heart failure is a chronic and progressive syndrome that requires self-care behaviors to promote wellness. Riegel and Dickson (2008) developed a Situation-Specific Theory of Heart Failure Self-Care as the basis for how patients with heart failure maintain health and avoid exacerbations (Riegel and Dickson, 2008). The Situation Specific Theory of Heart Failure Self-care of Heart Failure Model had two components, self-care maintenance and self-care management (Riegel and Dickson, 2008). Self-care maintenance focuses on the concrete behaviors of heart failure self-care (medication compliance, daily weights, fluid restrictions) and also monitoring (weight gain, fluid retention) (Riegel and Dickson, 2008). The second component, self-care management, involves more complex behaviors and contains three stages: evaluating symptoms, seeking and implementing treatment and evaluating that treatment (Riegel and Dickson, 2008).

Riegel, Lee & Dickson began to focus on lack of symptom recognition as a possible contributing factor for heart failure exacerbations (2010). Research exploring causation for this lack of symptom recognition found advanced age with its associated decrease in sensory feedback, as well as the confounding symptoms associated with comorbidities to be contributing factors (Jurgen, et al., 2013; Reeder, 2013; Vincent and Mutsch. 2015).

Jurgens, Lee, Reitano, and Riegel (2013) conducted a randomized controlled trial to determine why patients have difficulty recognizing and responding to heart failure symptoms. They randomized patients to a control and symptom training group and found that while the training group had more deaths or heart failure hospitalizations, it was not statistically significant (Jurgens, et al., 2013). They found that while there was no difference in 90-day event

free survival rates, self-care maintenance and self-care management improved significantly for both groups. In the training group however; self-care maintenance had a larger improvement of self-care maintenance and confidence scores. The authors called for inclusion of symptom management training to improve heart failure self-care interventions (Jurgens, et al., 2013).

In attempting to further understand difficulties heart failure patients experience translating heart failure knowledge into heart failure self-care, Harkness et al. (2015) performed a systematic review. They found that for patients to be successful, they had to adapt both perception and action-based strategies to maintain their health with heart failure (Harkness et al., 2015). Additionally, they called for health care providers to recognize that heart failure patients that are successful in self-care maintenance, have developed purposeful, calculated behaviors that often arose out of past experiences with heart failure management (Harkness et al., 2015).

Based on the research by Jurgens et al. (2013) and Harkness, et al., (2015), in 2016, Riegel, Dickson, & Faulkner recognized that there was a better understanding of how heart failure patients took care of themselves and revised their previous model to include symptom recognition as a third and separate component of self-care (Figure 3). They note that symptom recognition may occur independently or with the input of others (Riegel et al., 2016). Riegel et al. (2016) noted that as one component, e.g. symptom recognition improves, so typically do the other components (self-care maintenance and self-care management).

Riegel, Dickson and Faulkner's theory has three main revisions. First there is recognition that successful self-care involves symptom perception as an important component in how patients navigate heart failure self-care (Riegel, et al., 2016). Additionally, heart failure self-care may occur as independent self-care behaviors or as collaborative behaviors done with a support person or health care professional (Riegel et al., 2016). Finally, the revised theory put

greater emphasis on the Naturalistic Decision Making (NDM) process (Riegel et al., 2016) (Figure 4). Riegel et al. (2016), defines self-care as a "naturalistic decision-making process that influences actions that maintain physiologic stability, facilitates the perception of symptoms, and directs the management of those symptoms" (Riegel et al., 2016, p. 226). The NDM process has the three components of situation, process, and action which interrelate with one another, and help to identify how patients make decisions based in real time (Riegel, 2016).

The situation component incorporates the person, the problem, and the environment. (Riegel et al., 2016). Person characteristics are described as gender, age, cognitive status, health status, and income (Riegel, et al., 2016). Problem characteristics are described as comorbidities, previous assessment of symptoms, management of heart failure exacerbation, and ability to handle multi-step treatments (Riegel et al., 2016). Environmental characteristic can be described as access to care, access to medication, or living in an urban vs. a rural setting (Riegel et al., 2016).

The process component involves factors that influence self-care by prior experience, knowledge, skill, and value compatibility (Riegel et al., 2016). Experience with past heart failure self-care endeavors is felt to contribute to how patients incorporate knowledge and their own skill level. Knowledge is a multidimensional factor incorporating learning, complex decision making, association and processing of information Riegel et al., 2016). Riegel et al. (2016) note that experience and knowledge go hand in hand to influence decision making, by connecting patterns in situations to patterns of behaviors. The factor of skill is defined as making decisions and acting on decisions, is described as a factor that occurs due to experience and knowledge combining over time (Riegel et al., 2016). Lastly, value compatibility is a factor

in fostering self-care; the patient must deem that the actions are helpful or the right thing to do (Riegel et al., 2016).

The final component in the NDM process is action, which includes maintenance, symptom perception and management. These are active behaviors with which heart failure patients initiate and maintain self-care.

The authors note that heart failure patients are often faced with dynamic situations and competing demands (Riegel et al., 2016). These situations are often unique and the impact of the components of situation, process and action alter symptom recognition and self-care decisions (Riegel et al., 2016).

Given the comprehensive scope of heart failure self-care maintenance, symptom recognition, and factors that influence self-care management the Revised and Updated Model of the Situation Specific Self Care in Heart Failure theoretical framework was selected for this study (Riegel et al., 2016).

Methodology

Purpose of the study

Simulation games have been used successfully in chronic diseases like diabetes and asthma; however, little is known regarding the impact of heart failure simulation games on self-management and symptom recognition in patients with heart failure. Previously only one study was found that explored the impact of a simulation on heart failure knowledge and symptom self-management and self-efficacy elderly, community-based patients (Radhakrishnan et al., 2016). While the results for ease, usability and feasibility were promising, self-care was not assessed. The purpose of this study was to determine the effect of heart failure gamification on

heart failure self-care maintenance, symptom recognition and self-care management in patients recently discharged with a heart failure diagnosis.

Research Question

What is the effect of participating in a heart failure simulation game, Heart Failure Coach, after traditional heart failure education, on self-care maintenance, symptom recognition and self-care management in patients recently discharged with a diagnosis of heart failure?

Definition of Terms

Heart Failure Coach Simulation Game. A patient education video game to help reinforce patients' heart failure knowledge, symptom recognition and behaviors to avoid heart failure decompensation.

Patient Care Navigator. Certified nurse with specialty training to assist patients in navigating complex health care services across the continuum of care, and coordinate services in specialized care area and provided the traditional heart failure. The patient care navigator provided traditional education to patients in this study.

Self-care maintenance. Behaviors typically associated with adherence i.e. Medication compliance, daily weights, fluid restrictions, sodium restriction. (Riegel et al., 2016).

Self-care Heart Failure Index. Heart failure tool developed to assess patient self-care maintenance, self-care management and self-care confidence (Riegel et al., 2009).

Self-care management. Actions taken by patients in response to heart failure symptoms (Riegel, et al., 2016).

Symptoms recognition. Behaviors associated with body awareness, symptom perception, interpretation and acknowledgment of symptoms (Riegel et al., 2016).

Traditional Heart Failure Education. An established model of education used on the study unit for all patients admitted with a heart failure diagnosis and includes three components: the Krames'® Patient Education manual, entitled Living Well with Heart Failure (Krames, 2017), TIGR® video entitled, Congestive Heart Failure (UAMS Health, 2018), and individual consultation with education if gaps in the education were identified by the patient care navigator.

Research Design This study utilized a quantitative quasi-experimental design.

Setting

This study took place on a 25-bed inpatient unit, that admits primarily patients with heart failure and other cardiac conditions, in a 923-bed tertiary care hospital. Patients were approached and consented at bedside.

Approval of Setting. The director for evidence-based practice approved this study. The patient care director and patient care navigator on the study unit also agreed to have the study conducted on their unit.

Description of Sample

The sample consisted of patients hospitalized on the study unit, with the primary diagnosis of heart failure, who had completed traditional heart failure education by the patient care navigator. The enrollment goal was 30 patients.

Inclusion Criteria. Inpatients admitted with a primary or secondary diagnosis of heart failure over the age of 18.

Exclusion Criteria. Inpatients with psychoneurological disorders impacting cognition (such as documented dementia or delirium), inability to understand spoken or written English and

respond to English language questions, and inability to complete the Heart Failure Coach simulation game with more than minimal assistance.

Intervention

After completion of traditional heart failure coach education by the patient care navigator and consent was obtained, patients completed demographic data and the SCHFI. Patients were introduced to The Heart Failure Coach game on the researcher's I-pad. The researcher demonstrated use of the Heart Failure Coach game. This game was developed by SimCoach, a technology company that develops simulation games to be utilized in healthcare and the University of Pittsburgh Medical Center (UPMC). The game shows Simon as a virtual patient recently discharged from the hospital and patients were asked to help Simon perform heart failure self-care such as daily weights, dietary sodium and fluid restriction, and medication compliance. Patients were also asked to assess Simon's symptoms and help devise a management plan for those symptoms. At the conclusion of the simulation, patients were informed how successful they had been at keeping Simon healthy. Areas to improve were identified by the Heart Failure Coach, and reviewed by the researcher with just in time education provided. The game took approximately 20 minutes to complete.

Procedures

1. The researcher obtained IRB approval through the healthcare system of the study site and the University of Virginia
2. The researcher presented the proposal to the Nursing Evidenced Based Practice Council of the study site in August of 2018.
3. The researcher provided in-services about the purpose and procedures of this study to the nurses on the study unit in September of 2018. A poster was placed on the

unit to educate staff members unable to participate in staff meetings, and to serve as a reference during the course of the study.

4. Patients who were eligible for the study completed traditional heart failure education overseen by the patient care navigator. This education consisted of three components: Krames'® patient education manual entitled, Living with Heart Failure, (Krames, 2017), viewing TIGR® video entitled, Congestive Heart Failure (UAMS Health, 2018), and private consultation and individualized education by the navigator utilizing a symptomatic recognition tool by severity zone approach Monday through Friday. The TIGR® video (Appendix is an interactive video viewing education system that is developed for healthcare use (UAMS Health, 2018). The heart failure zone instruction incorporates education regarding medication, fluid restriction, sodium restriction, weight monitoring and symptom monitoring (Appendix M).
5. The researcher reviewed the daily census to screen for patients who met the inclusion criteria or who were to be excluded. The researcher utilized the EMR and the input from the bedside nurse to verify which patients met inclusion criteria or were excluded because English was not their primary language or had documented psychoneurological disorders. After the researcher verified which patients met the inclusion criteria, the researcher verified that the traditional heart failure education had been completed by the patient care navigator. This verification occurred typically on a Monday, Wednesday and Friday throughout the implementation phase of the study.

6. Patients that met inclusion criteria and had completed traditional heart failure education were approached by the researcher to verify interest of participation in the study.
7. Once consent was obtained, demographic information was obtained and the patient completed the self-care in heart failure index (SCHFI) questionnaire (Appendix I).
8. The researcher then set up the Heart Failure Coach game on a personal I-pad and was present while the patient completed the game. Estimated time of completion was approximately 20 minutes. If the patient had a support person present during the game, the support person was invited to participate in answering the questions posed during the playing of the game. The researcher tracked if a significant other participated in the game, as well as the relationship of the significant other. The patient was required to activate the response button.
9. After the patient completed the Heart Failure Coach game, if the game identified opportunities for improvement, the researcher provided just in time education to the patient consistent with traditional heart failure education. The patient then completed a 12-item patient satisfaction questionnaire (Appendix F). This Likert based survey measured ease of use and likability of the Heart Failure Coach game, benefit derived in heart failure self-care maintenance, symptoms recognition, and self-care management. Additionally, the patient was asked in open-ended format what information they would have liked the Heart Failure Coach to have included, and if there was any further information they would like to receive. Data about additional TIGR® videos (UAMS Health, 2018) viewed by the patient was also collected.

10. At the completion of the Heart Failure Coach and just in time education, the researcher provided a laminated card with pictures of the Heart Failure Coach and the researcher to the patient (Appendix N) . The card served as a reminder to the patient that the researcher would contact the patient by phone in one week after their discharge and provided the researcher's practice setting email.
11. The researcher called each patient one week post-discharge to complete a follow-up SCHFI questionnaire. If the patient was not reachable, by first attempt, the researcher left a voice-mail message if possible. The message reminded the patient that the researcher was calling to complete the questionnaire and provided the researcher's healthcare system email if they wish to set a time for a return phone call. If the patient was unavailable, the researcher attempted to contact the patient two additional times in 48-hour intervals and left an identical message. If there was no patient response, the patient was coded as lost to follow up.
12. If the patient was assessed as having possible signs or symptoms of heart failure during the follow up phone interview, the patient was instructed to contact their cardiologist for further evaluation.

Protection of Human Subjects

This proposal was submitted to the Institutional Review Board (IRB) at the doctoral student's university and practice site. Collaborative Institutional Training Initiative (CITI) training was completed prior to IRB approval (Appendix D), as well as WIRB Copernicus Group (WCG) training required by the practice site for human research (Appendix E). Names were de-identified for this study, with all findings presented as group data to protect anonymity of the

patients. All questionnaires were stored in a locked cabinet and were maintained according to the healthcare system's IRB protocol. All data was stored on the healthcare system's firewall protected data-bases of the researcher's practice setting.

Measures

Two instruments were utilized in this study. The first instrument was the Self-Care in Heart Failure Index v 6.2 (SCHFI) by Riegel et al. (2009). The SCHFI was developed and tested on patients with heart failure, and was used to measure the effect of gamification on self-care. The instrument is comprised of three subscales: self-care maintenance, self-care management and self-care confidence. There is no overall SCHFI score. Each subscale is scored with a range of 0-100, with patients who score 70 or greater considered competent in that area of self-care.

The self-care maintenance subscale is comprised of 10 questions that focus on behaviors patients are prescribed to maintain health and avoid symptoms of heart failure (Riegel et al. 2009).

The self-care management subscale is comprised of six questions; two that focus on the recognition of symptoms and management behaviors (decreasing dietary sodium and fluid intake, taking an additional fluid pill, and contacting a provider for guidance to manage heart failure symptoms). For this section to be scored the patient must have recognized symptoms of shortness of breath or ankle swelling (Riegel et al, 2009). Failure to have these symptoms, precludes further scoring of the self-care management subscale (Riegel et al.. 2009).

The self-care confidence subscale is comprised of six questions. Two questions relate to self-care maintenance and four questions relate to self-care management.

According to Riegel et al, (2009) the confidence scale score should be used to assess the relationship between self-care and outcomes, not of self-care itself (Riegel et al., 2009).

Psychometric testing of the SCHFI instrument found coefficient alpha, the reliability coefficient, to reveal variation between the self-care maintenance, self-care management, and self-care confidence (Vellone, Riegel, Cocchieri, Barbaranelli, & D'Agostino et al., 2013). Vellone et al. (2013) performed exploratory factor analysis, followed by confirmatory factor analysis in 659 Italian heart failure patients. They found comparative fit indices (CFI) of .92 for the self-care maintenance scale, .95 for the self-care management scale, and .99 for the self-care confidence scale. Similar levels for internal consistency and test-retest reliability was also found (Vellone et al., 2013). The reading level of the items on the SCHFI was not reported. The SCHFI was anticipated to take 10-15 minutes to complete.

The second measure utilized in this study was a questionnaire developed by the researcher to determine patient satisfaction with the Heart Failure Coach (Appendix F). The questionnaire was administered immediately upon completion of the Heart Failure Coach game. Items were written by the researcher at a primary reading level and a clinical expert validated the content. Estimated time to complete the questionnaire was approximately 10 minutes.

The questionnaire was comprised of 12 questions. Nine questions utilized a Likert based approach to measure ease of use and likeability of the Heart Failure Coach game, benefit derived in heart failure self-care maintenance, symptom recognitions, and self-care management. Additionally, the patient was asked three questions that focused on heart failure education. Two of the three questions were asked in an open-ended format related to patient preferences related

to additional education from the Heart Failure Coach or traditional heart failure education. The final question queried whether any additional TIGR videos were viewed, using a yes / no format.

Data Analysis

Descriptive and inferential statistics were performed utilizing SPSS v. 25 (IBM Corp., Armonk, NY, USA). Demographic data included age, gender, race, education level, comorbidities (diabetes, hypertension and hyperlipidemia), if the current heart failure episode was a first-time diagnosis, the New York Heart Failure Classification and whether the game was played with a support person. Patients' SCHFI scores were calculated for all patients, to assess the level of self-care before and after gamification simulation. The before and after SCHFI scores were analyzed for statistical significance, utilizing paired t-testing. The patient satisfaction questionnaire utilized Likert scale questions regarding ease of use, likability, patient perceived effect on heart failure knowledge, heart failure symptom recognition and self-management of heart failure was analyzed utilizing descriptive statistics. Patients' responses to the open-ended educational question (desired additional content to be covered by Heart Failure Coach or other desired information) were categorized by self-care maintenance, symptom perception, or self-care management with frequency analysis employed. Frequency analyses were also utilized to assess the viewing of additional TIGR® heart failure videos beyond the TIGR® video included in prior traditional heart failure education.

Results

During the eight weeks of patient enrollment, 107 patients on the advanced heart failure unit were screened. Of these 107 patients, 68 did not meet inclusion criteria. Thirty-three patients were excluded due to neuropsychiatric criteria, four patients did not speak English, 19 patients were undergoing treatment pre or post heart transplant, or left ventricular assist device, three patients had enrolled in hospice care, and nine patients had not yet been taught by the patient navigator. Of the 39 patients who met inclusion criteria and were approached for consent, 19 refused. This resulted in a sample of 20 that were enrolled in the study. Two patients were lost to follow up and one died. Seventeen patients were included for pre and post heart failure education evaluation.

The age of the sample ranged from 27-91 years with a mean age of 61.15 years (SD = 15.58) and was predominantly male (65%) and white (75%). Thirty percent of the patients completed college and 45% completed post graduate studies. Forty-five percent of the patients had NYHA functional Class III heart failure, and 50% had NYHA functional Class IV heart failure. Only 25% were admitted with a new diagnosis of heart failure. Prior history of diabetes, hypertension and hyperlipidemia was 45%, 75% and 70% respectively. Six patients (30%) played the Heart Failure Coach game with a support person present who was their spouse. (See Table 3 for demographic characteristics).

Descriptive statistics for the patient satisfaction questionnaire revealed 90-100% of patients agreed or strongly agreed that the Heat Failure Coach was helpful with recognizing the importance of daily weights, medication adherence, dietary sodium intake, fluid restriction, and calling a provider if symptoms worsen. One hundred percent of respondents agreed or strongly agreed that the Heart Failure Coach was easy to play, and 95% of patients agreed or strongly

agreed they liked the Heart Failure Coach (See Table 4 for descriptive statistics, usability and satisfaction responses).

Nine of the 20 patients (45%) listed education items they would like additionally addressed by the Heart Failure Coach; five areas addressed self-care maintenance, two addressed symptom recognition and two addressed self-care management (See Table 5). Three patients (15%) listed education items they would like covered by traditional education; one item addressed self-care maintenance and 2 items addressed symptom recognition. Just four patients (20%) had viewed additional TIGR education videos. (See Table 5 for responses to patient satisfaction questionnaire).

Mean pre-Heart Failure Coach SCHFI and post- Heart Failure Coach SCHFI scores for self-care maintenance were 57.28 $\pm$ 18.20 and 73.00 $\pm$ 9.07 respectively. This reflected an increase in 15.72 ($t = -3.769$, CI 95% [-24.58 - -6.88], $p = 0.002$). Mean pre-Heart Failure Coach SCHFI and post-Heart Failure Coach SCHFI scores for confidence were 56.56 $\pm$ 20.81 and 82.03 $\pm$ 10.67 respectively. This reflected an increase of 25.49 ($t = -4.570$, CI 95% [-25.49 - -13.67], $p < 0.001$). (See Table 6 for pre and post test results). Only three patients experienced symptoms of shortness of breath or ankle swelling in the week after hospital discharge. According to the SCHFI scoring directions, the subscale in self-care management is not used unless patients have symptoms. Given the small number of patients (n=three), statistical analysis was precluded in the self-care management subscale.

Discussion

This study explored heart failure gamification and its impact on heart failure self-care. The purpose of this study was to determine the effect of heart failure gamification on

heart failure self-care maintenance, symptom recognition and self-care management in patients recently discharged with a heart failure diagnosis.

The study sample was predominantly male, white, well educated, and most carried a prior diagnosis of heart failure as NYHA class III or IV heart failure. The patients demonstrated significant improvement in SCHFI self-care maintenance and self-care confidence subscale scores after participation in heart failure gamification. These findings were consistent with Lee and Riegel's (2018) prior work, that found prior hospitalization, higher level of education, poorer functional status facilitated self-care symptom recognition. These findings occurred despite that patients in this study were older, and most carried co-morbidities, which Lee and Riegel (2018) found made symptom recognition difficult.

Self-care Outcomes

The increase in self-maintenance subscale scores after completion of the Heart Failure Coach were comparable to outcomes due to nurse driven education in other studies. Three studies were found that added an educational intervention to traditional heart failure education similar to this study's intervention. However, none used gamification. Awoke, Baptiste, Davidson, Roberts and Dennison-Himmelfarb (2019) studied the effect of a nurse-led education program on knowledge, self-care, and readmission rates in 29 patients admitted for heart failure. Their sample demographics were similar to the demographics of this study in age, gender, and NYHA class with an average age of 66 years, 52% male, 35% Caucasian, 62% African American and 69% with NYHF class III or IV (Awoke et al., 2019). Patients baseline SCHFI scores were obtained before, at seven days and 30 days after the provision of nurse-led inpatient heart failure education. This nurse-led heart failure education incorporated the 2013 guidelines from the American College of Cardiology Foundation and American Heart

Association for dietary and fluid restrictions, medication compliance, smoking cessation and compliance with follow up care. Patients were then provided a symptom recognition and management guide based on their symptom severity zone. Self-care maintenance scores were improved at 7 days ($p \leq .000$) and 30 days ($p \leq .000$).

Similar findings were echoed by Liou, Chen, Hsu, Lee, Chang, and Wu (2015) in their study of a heart failure self-care program of 133 Taiwanese patients admitted with heart failure and randomized to standard heart failure education or self-care heart failure education. The standard heart failure education group received education that focused on heart failure symptoms and compliance to treatment. The self-care heart failure education group received a booklet, viewed a heart failure video, and received a day long individualized self-care education session focusing on medication compliance, dietary sodium and fluid restriction, lifestyle changes, exercise, and symptom assessment and management. Their reported demographics were an average age of 62 for both groups, predominantly male (77% standard group, 55% self-care group), NYHA III (44% standard, 54% self-care) and no NYHA IV patients in the study. Baseline SCHFI scores were obtained the SCHFI was re-administered by phone seven- and thirty-days post discharge (Liou et al., 2015). They found significant improvement in self-care maintenance at seven days and at the thirty-day post discharge utilizing SCHFI assessment ($p < .05$ and $p < .001$ respectively) These studies suggest that nurse-led self-care education may have a positive impact on self-care reports post heart failure hospitalization.

In this study the improved self-care maintenance scores may additionally be due to the interactive approach which promoted active learning of self-care maintenance activities (daily weights, medication compliance, dietary sodium intake and fluid restriction) by utilization of real-life scenarios to reinforce the importance of consistency with this care. Stromberg, Ahlen,

Fridlund, and Dahlstrom (2002) found similar findings when they utilized interactive heart failure education. Stromberg, et al. (2002) utilized a CD-ROM program with eight modules, seven providing education in areas of heart failure, physiology, symptoms, diagnosis, medications, self-care and frequent questions. The last module was a self-test that employed visual and auditory reinforcement during the testing. Stromberg et al. (2012) found that computer-based heart failure education was interactive, flexible and patients found it a preferred method of learning than written education or viewing videos.

Self -care confidence scores also significantly increased after participation in the Heart Failure Coach consistent with other studies of heart failure patients after discharge. Awoke et al. (2019) reported significant increase in self-care confidence scores at the 30-day time point but not at seven-day. Liou, et al. (2015) had similar findings in self-care confidence at both seven-day ($p < .05$) and 30-day (add the statistic add the t test $p < .05$) follow up assessment. Vellone, Pancani, Greco, Steca, & Riegel (2016) found that self-care confidence was an important factor in heart failure patients, particularly with cognition deficits. Vellone, et al. (2016) explored the effect of self-care confidence in mediating the relationship between attention and heart failure self-care, as well as the relationship between working memory and heart failure self-care. They called for further studies exploring interventions that improved self-care confidence over cognition in heart failure patients (Vellone et al., 2016).

The improvement in the self-care confidence scores after completing the Heart Failure Coach in this study may reflect that the patients were put in simulated situations, and asked to assess symptoms and make an appropriate plan, e.g. to call a provider or take an additional diuretic. This simulation may have led to increased retention of facts related to managing their heart failure. Additionally, the Heart Failure Coach afforded patients the opportunity to work

through symptom recognition processes and plan with a support person, which also may reinforce their self-care behaviors and increased self-care confidence.

The self-care management subscale of the SCHFI was completed by all patients prior to playing the Heart Failure Coach game. Statistical analysis was not completed due to the low number of patients (n =3) that experienced symptoms one week after hospitalization. Following the SCHFI v. 6.2 scoring guideline, self-care management subscale scores are not to be analyzed unless symptoms occur. In previous studies, Awoke, et al. (2019) reported statistically significant findings in self-care management with SCHFI assessment follow up at 7 days ($p < .001$) and at 30 days ($p < .013$). Liou et al. (2015) found statistical significance at 7 days and 30 days, in their follow up SCHFI assessments ($p < .05$ and $p < .01$ respectively). Symptom recognition could also not be analyzed in this study, as it was incorporated as part of the self-care management scale. It is possible that symptom recognition and self-care management activities would have been present and therefore measured by the SCHFI, if this study had employed a 30-day post hospitalization evaluation as in the Awoke et al., (2019) and Liou et al. (2015) studies.

Gamification and its role in Heart Failure Education

Self-care management and symptom recognition could not be assessed in this study due to the low number of patients with symptom expression. Gamification has been utilized as a means to impact knowledge and self-care management in other chronic illnesses. Heinrich et al. (2012) studied the effect of gamification in diabetic patients utilizing DIEP (Diabetes Interactive Education Programme) and found a significant effect on knowledge ($p < .01$) though only half of the patients utilized the self-care management component (Heinrich, 2012). Study patients reported that the DIEP was strong in content, credibility, user friendliness, and noted that it provided another means of education other than written education (Heinrich, 2012). Lehman et

al. (2014) studied AIDA (Action, Insulin and Diet Adjustment) gamification for diabetics, which has been utilized for 15 years as a simulation game for glucose and insulin control. They found that AIDA gamification had a significant impact on symptom recognition and self-care management in the diabetic population (Lehman et al, 2014). Greenwood, Gee, Fatkin, and Peeples (2017) in a systematic review and meta analyses focusing on the use of technology in diabetes self-management, education and support, found that technology improved hemoglobin A1C levels in 18 of 25 articles reviewed. Incorporating technology that enabled self-management, fostered communication between the patient and their healthcare team, analyzed the individual health data with tailored education, and provided prompt feedback were recognized as key interventions recommended by the United States National Standards for Diabetes Self-Management Education and Support (Greenwood, et al., 2017).

The literature suggests that gamification is a new approach in heart failure education and management as well. Dilles et al. (2011) in a non-superiority study with hospitalized heart failure patients found that computer assisted heart failure education was as effective as written heart failure education. Dithmer et al. (2016) utilized The Heart Game in a telerehabilitation program for recently discharged patients, predominantly with myocardial infarction. The game engaged patients and their support person to engage in healthy choices and connected them with other patients playing the game (Dithmer et al., 2016). The patients and their support person reported feeling that the tasks of the game provided a means for them to return to health and enjoyed the social networking with others (Dithmer et al. 2016). Senior adults (age 65 or older) also find benefit in digital game playing. Duplaa et al. (2017) studied 590 Canadian non-hospitalized seniors who were self-described digital game players and found digital games had cognitive and socioemotional benefits.

Patients reported high levels of satisfaction with the Heart Failure Coach game. Patients rated the Heart Failure Coach consistently as helpful in heart failure maintenance, symptom recognition, likeability and usability. Similar findings of likability and usability were found in prior study by Radhakrishnan et al. (2016) who measured the impact of a digital heart failure game prototype on self-care knowledge and self-care efficacy. Likability and usability were both 100% ; self-care measures were not reported (Radhakrishnan, et al., 2016). More patients in this study reported that they preferred additional education to be presented by the Heart Failure Coach (45%) over traditional education (15%). Similar findings were noted with Radhakrishnan et al. (2016), who found patient with lower education levels preferred games to any other educational method ($p < .02$). While self-care measures were not assessed these findings support that the Heart Failure Coach was easy to use, reinforced education, provided an alternative method of education, allowed for problem solving and encouraged the role of a support person.

Limitations

There were limitations to this study. First, the sample in this study was a small, non-randomized convenience sample recruited in a short time period. During enrollment, many of the patients on the units were pre or post heart transplant patients that further limited eligible patients. Another limitation was the prevalence of psychoneurological factors that excluded 33 of the 107 patients (30.8%) A final limitation to the study design was the symptom expression in this sample. According the SCHFI v. 6 .2 guidelines, the patient must have symptoms of shortness of breath or ankle swelling to score the self-care management subscale as only three of the 17 patients had one of these symptoms, symptom recognition and self-care management could not be accurately assessed. A new SCHFI (v. 7.2) has been developed, which allows for

measurement of symptom recognition and self-care management specifically (Self-care measures.com, 2019). Psychometrics for the SCHFI v. 7.2 were not available during the implementation of this study, but have subsequently released (Riegel et al., 2019).

Practice Implications

The Heart Failure coach was an effective means of reinforcing self-care in heart failure education. Placing patients in virtual heart failure scenarios prior to discharge, helped to identify opportunities for clarification or further education opportunities before leaving the acute care setting. The results of this study indicated that an innovative approach, such as gamification, in addition to traditional heart failure education may impact future heart failure self-care. More study is needed given the very limited report of gamification in heart failure patients in the literature and given that decades of traditional heart failure education have shown to increase knowledge but not reduce readmissions. If the main goal of heart failure education is to increase patient knowledge and skill in managing their selfcare, then innovative ways to increase active learning and real-life situations has potential to impact on heart failure exacerbation and relapse.

Playing with a support person was also a unique feature of the Heart Failure Coach. The literature supports the role of the support person in fostering self-care maintenance, in helping to assess symptoms, and act on those symptoms (management). Heart failure gamification offers an objective assessment for care providers of readiness in independent or codependent heart failure self-care. Yunus and Sharoni (2016) studied the role of social support and self-care management in 113 outpatient cardiology patients. Their study found a positive correlation between social support and self-care management, and suggest that social support be used as a predictor in patients with heart failure (Yunus and Sharoni, 2016). Finally, patients listed a

greater number of educational items they desired to be addressed by the Heart Failure Coach versus traditional education methods. This may have impact in the role of the heart failure educator and how that education is provided.

Future Recommendations

In the future, this study should be repeated with larger, randomized sample comparing traditional heart failure education to heart failure education utilizing gamification. Ideally this would occur for a longer duration lending to multiple follow-up SCHFI scoring points (e.g. seven days, 30 days and 90 days). Continuing to utilize Riegel et al., (2016) Situation Specific Theory of Heart Failure Self-care, with the SCHFI v. 7.2 should be employed to assess self-care maintenance, symptom recognition and self-care management. Ultimately studying the impact of heart failure gamification on resistant outcomes, e.g. exacerbations and readmissions, should be a focus.

Conclusion

This was a quantitative quasi-experimental study that examined the effect of a simulation game on self-care maintenance, symptom recognition, and self-care management in hospitalized heart failure patients after their completion of traditional heart failure education. This study was relatively easy to employ and well received by patients and their support person. The SCHFI v. 6.2 was utilized to assess the effect in heart failure self-care, with significant improvement noted self-care maintenance and self-care confidence ($p < .002$ and $p < .001$ respectively). Due to only three out of 17 patients experiencing symptoms of shortness of breath or ankle swelling in the week post-discharge, self-care management and symptom recognition could not be analyzed utilizing the scoring guidelines.

Heart failure gamification used in this study did improve heart failure self-care maintenance and confidence. Gamification may be an innovative method to improve patient heart failure knowledge; and may serve as a preferred method of heart failure education particularly in patients with lower education level. The Heart Failure Coach was well liked and easily used across all ages. . It provided a simulated environment for education that could be done independently or with a support person. Further exploration of the use of heart failure gamification in the role of heart failure symptom recognition and management should be explored.

Products of the Study

A completed report will be submitted to the University of Virginia School of Nursing and submitted to the University of Virginia Health Science Library. The findings of this study will be reviewed with the nursing and support staff of the hospital unit on which the research study took place, the healthcare system's Evidence Based Practice Nursing Council, SimCoach, and the University of Pittsburgh Medical Center. A poster will be created and submitted for review to the Healthcare System's Heart Failure Symposium. A manuscript will be electronically submitted to a peer review journal.

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Table 1.

STUDY DESIGN OF HEART FAILURE AND SYMPTOM RECOGNITION

Study	Subjects and Setting	Design	Intervention and Comparison	Outcomes
Altice, N., Madigan, E., (2012)	Sample: 75 patients with recurrent NYHA classes two – four with recurrent heart failure symptoms Setting: Tertiary Medical Center	Descriptive correlational study	Patients identify from daily admission list by M.D. and staff referral. Medical records reviewed for appropriateness. Researcher interview during hospitalization with a questionnaire (HFSPS) and open-ended questions.	HFSPS average was 37.52. Subjects reporting two – sixteen out of 18 symptoms with duration from five minutes to eight years. Patients identified acute and chronic symptoms. Limitations: small convenience sample form acute care setting, mostly white older population, limiting generalizability.
Boyde, et al., (2017)	Sample: 200 hospitalized patients in Australia Setting: Tertiary Medical Center	Randomized Controlled Trial	Patients randomized (1:1) to usual education or multimedia education intervention	At 12 months 24 patients admitted in the intervention group vs. 44 in the usual standard of care group. 30% decrease of risk of readmission in the intervention group.
Clark, et al. (2011).	58 studies involving 990 patients (274 female and 527 male).	Qualitative Systematic Review	A systematic search conducted to identify studies published as full papers after 1995 reporting primary qualitative data with heart failure specific data or themes related to help seeking by caregivers or	Heart failure help seeking was part of the experience but ongoing symptoms were elusive. Little support available to interpret the significance of symptoms. Other barriers to seeking care were avoidance-coping, fear of hospitals and reluctance to be burdensome.

			health professionals and the results.	Limitations: not addressed by authors.
Clark, et al., (2015)	Subjects: 50 people diagnosed with Class I – III heart failure. Mean age = 62.4 years with slight majority of female patients Setting: One city outside of Austin Texas in Home setting	Randomized controlled trial	Subjects were randomized to two groups with 25 patients each. Interventi on group received frequent phone education with assessment at initiation, 3months, 6 months and 9 months. The control group received a spiral notebook with generic information on aging, bladder control, with no information regarding heart failure.	The intervention group showed significant improvements in functional status, self-efficacy, and quality of life. Both groups improved on depression scales. Limitation: Sample size was small, geographic location was specific. The age was also younger than many with heart failure and bias may have been introduced as the APRN who provided the intervention was also collecting the data.
Dracup, et al., (2014)	Sample: 602 patients with systolic heart failure having been hospitalized with heart failure in the past 6 months. Setting: recruited from 12 clinics for hospitals in Kentucky, California and Nevada	Randomized Controlled Trial	Randomization in to three groups – all received face to face education. Gro up one received education alone, group two received education and two follow up phone calls, group three received education and biweekly phones calls till RN determined	Face to face education did not decrease end points of cardiac death or hospitalization. Increa-sing follow up contact did not significantly improve outcomes of hospitalization or death.

			patient was adequately trained	
Evangelista, L., Dracup, K. and Doering, L. (2000).	753 patients discharged from Greater Los Angeles, CA Veterans' Administration Hospital admitted with Heart Failure from 1997 through 1998.	Retrospective Study	Descriptive statistics to characterize the duration of delay before admission, type of symptoms that patients reported on admission, and sociodemographic and clinical variables. Because no pre-determined classification time exists for HF patients, we conducted analyses using the median delay time of 3 days (72 hours) from the current sample to create 2 groups of patients: those with short delay times (≤3 days) and those with long delay times (>3 days).	Of the 753 patients in the sample, 220 (29.2%) patients had more than 1 admission (range, 2 to 9; mean, 2.79 readmissions). delay time decreased with repeated admissions to 1.86 6 1.93 days (44.6 hours) for the second admission (n 5 220), 1.47 6 1.57 days (35.3 hours) for the third admission (n 5 89), 1.33 6 1.13 days (31.9 hours) for the fourth admission (n 5 45), and 1.21 6 0.92 (29.1 hours) for the fifth admission (n 5 19). Limitations: the study was retrospective, male dominated 97.8%, and involved only veterans.
Evans, M. (2016)		Integrative review of the literature		Patients and providers should be more aware of subtle heart failure symptoms. Patients often seek care at the advice of support person and past heart failure history Limitation: Small sample size in quantitative studies and

				incomplete recording in qualitative studies
Gallagher, et al., (2012)	Sample: Convenience sample of 242 patients enrolled in the heart failure support program. Setting: Patients presenting through the emergency department with primary diagnosis of heart failure in one area health service program in Sydney, Australia	Quantitative and qualitative review of symptom patterns and duration and associated predictors occurring prior to first heart failure admission	Utilizing the Managing Cardiac Function (MACARF) tool, nurses interviewed patients regarding occurrence of 10 symptoms, duration, and length of time prior to presenting to the emergency department	Patients were noted to experience up to seven symptoms (average 2.7) with a median of 4.47 days (range of 1-7 days) prior to presenting. Only 48% contacted a health professional prior to presenting to the emergency department. Limitations: Limited to newly diagnosed heart failure patients, and excluded patients with symptoms but were not hospitalized.
Harkness, et al., (2015)	Sample: patients from 47 studies	Systematic Review using qualitative meta-synthesis (studies contained a qualitative end data pertaining to heart failure self-care)	A review of approaches to self-care. Both perception and action-based strategies were reviewed.	Heart failure patients expressed difficulty to how integrate self-care recommendations into their daily lives. Self-care was viewed as an adaptation to maintain their independence and quality of life.
Jurgens, C., Lee, C., Reitano, J., Riegel, B. (2013).	Convenience sampling of 99 patients with confirmed chronic heart failure Setting: Suburban New York tertiary hospital and surrounding community (Feb 2007 – January 2011).	Randomized Controlled Trial to trial efficacy of Heart Failure - symptom training intervention vs. usual care	Patients were educated with newly developed HF SMART tool. All patients were provided with a weight scale, HF self-care booklet Patients were randomized to intervention	Of the 99 patients 27 were hospitalized within 90 days. The intervention group had more events than the nonintervention group (though not statistically significant). There were improvements in self-care maintenance and confidence scores in the intervention groups

			group received additional one-on-one HF SMART training on how to recognize and respond to symptoms	Limitations: small sample size in part due to competing studies,
Lam, C. and Smeltzer, S. (2013).		Integrative Review of the Literature to examine self-reported patterns of symptom recognition	Seven studies utilized chart review, seven studies utilized a prospective approach and two studies utilized mixed-methods for analysis	Descriptive research was predominantly used to study symptomatology. Dys-pnea was the most common symptom with inconsistency in description and duration. Newly diagnosed, as well as elderly heart failure patients are more likely to delay seeking treatment
Lee and Riegel (2018)		An Integrative Review of eight data-bases	Twenty-one studies met the inclusion criteria with studies categorized in to symptom monitoring or symptom recognition and interpretation	Daily weight monitoring and heart failure symptom monitoring were insufficient in preventing exacerbation in patients. Symptom diaries, improved heart failure self-care, symptom distress, functional class, and decreased hospital stay and mortality. Heart failure symptoms remain difficult to identify. Limitations: Symptom perception is a newer concept to the Situation specific model of self-care and heart failure limiting the available

				studies. Additionally, these studies predominantly occurred in the United States and may lack generalizability
Reeder, K., Ercole, P., Peek, G. and Smith C. (2015)	Subjects: 60 patients hospitalized for acute decompensated heart failure Setting: Inpatient	Semi-structured interviews to examine pre-hospital admission scenarios	Patients were interviewed regarding their recognition of symptoms, their treatment strategies and duration of symptoms	61.7% of patients recognized that "something wasn't right" but were unable to specify further. Dyspnea was noted 85% of the time followed by fatigue (53.3%) and edema (41.7%) "Few" patients attributed their symptoms to heart failure Limitations: Small sample size
Riegel et al., (2009)	29 patients with NYHA Class II or Class III heart failure (Excluded were myocardial infarction less than 6 months prior, COPD, thyroid disease, weight loss of unknown etiology, and use of psychotropic medications. Setting: Enrollment and data collection took place at 4 out-patient sites in Melbourne, Australia	Cross Sectional Mixed Method study with the sample divided at the mean age (<73 years) to compare younger vs older patients to detect and interpret heart failure symptoms	Use of qualitative interviews to assess symptom, medical chart review with focus on gender, functional status, body mass index, fitness and perceived health with comparison in those less than 73 years old and those older than 73 years old	Uncertainty of symptom awareness with most notable in older patients with call for interventions to help improve awareness or use the assistance of a support person. Limitations: cross sectional nature of study, pattern of symptoms may vary and influence interpretation. In some cases, the interview occurred post event, and recall may have been affected
Sethares, K., Sosa, M-E., Fisher, P.,	131 adults (55% male, with average age of 77 years) with heart failure	Exploratory Descriptive Study	Data collection by interview on factors affecting patient	Media delay time was 60 hours with range from 1 to 336 hours 25.9% sought care in

Riegel, B. (2014).	diagnosis of 3 months or longer Setting: Hospitalized		experience, response to symptoms, and delay time during the patient hospitalization.	less than 12 hours. Three variables were statistically significant for determining long delay in seeking treatment: waiting to see if symptoms would subside, passive response from others, and living in a rural community.
White, M., Howie-Esquivel, J., and Caldwell, M. (2010).	Parent Study utilized 36 patients with 20 randomized to an intervention group and 16 randomized to a control (usual care group) This study focused on the analysis of the 20 patients in the intervention group	Randomized Controlled Trial Analysis of data of heart failure diaries	Post heart failure teaching of the patient (spouse or significant other were encouraged to attend) the patient was asked to record their daily weight, symptoms, and unplanned hospital visits, or physician contacts.	16 of the 20 diaries were returned. 79.4% were compliant with weight monitoring. 75% of those patients experienced weight gain of 3lbs of more in one day. Of those 75%, 33% experienced 5 or more episodes of greater than 3lb weight gain. Only one patient contacted their physician.
White, M., Garbez, R., Carroll, M. and Howie-Esquivel J. (2013)	276 patients older than 65 years hospitalized with HF over a 13-month period.	Prospective cohort study design	Patients were educated and evaluated using the teach-back method as part of usual care. Data on ability to recall educational information while hospitalized and during follow-up approximately 7 days after hospital	The teach-back method was an effective method used to educate and assess learning. Patients educated longer retained significantly more information than did patients with briefer teaching. Correctly answered HF-specific teach-back questions were not associated with reductions in 30-day hospital readmission rates. Future studies that

			discharge were collected. Readmissions were confirmed through follow-up telephone calls and review of medical records.	include patients randomized to receive usual care or teach-back education to compare readmissions and knowledge acquisition would provide further comparison of teach-back effectiveness.
Wu, et al. (2017)	482 patients admitted with a primary or secondary diagnosis of exacerbation of heart failure. Setting: A tertiary referral medical center	Retrospective chart review	Electronic and paper medical review to identify signs and symptoms of heart failure prior to presenting for treatment. Additionally, looked at precipitating, psychosocial and behavioral factors that may have influenced their presentation.	346 of 482 patients had data on delayed time to presentation. Average time from symptom time to seeking treatment was 16 days. Mean length of stay was seven days with a median of four days. There was a significant delay time between number of signs of symptoms before admission. No relationship was detected between delay time and length of stay or delay time and number of admitting factors on presentation. Five factors were positively or negatively associated with delays to seeking treatment: depression, recent change in heart failure medicine, renal failure, poor medication adherence and hyper tension. Limitations: retrospective, information was documented by other clinicians and retrieved

				from medical records (precipitating factors may not have been recorded), geographic location (one southeastern state), and compliance with Medicare heart failure measures

Table 2.

STUDY TABLE FOR HEART FAILURE AND GAMIFICATION

Study	Subjects and Setting	Design	Intervention and Comparison Intervention	Outcomes
Dilles, et al., (2010)	Convenient Sample: 37 heart failure patients Setting: inpatient and outpatient post visits discharge	Quasi-experimental design	Computer Assisted Learning (CAL) versus 16 in standard care (brochure and oral education from RN teaching)	Non-superiority study both educational strategies increased knowledge and improved self-care. Limitations: small sample size, non-standardization of nurse teaching, male gender dominant, 19% dropout rate
Dithmer, et al., (2016)	Sample: 10 heart patients (ages 48-49 years) Setting: outpatient as part of their telerehabilitation	Observational Study – Qualitative	Interviews, patient observation, focus group and workshop	Found to be a useful tool in achievement and engaged family members. Limitations: Observational study without randomized controls, small sample size
Duplaa, Kaufman, Suave and Renaud (2017)	Sample: Canadian Seniors (55yo or greater) residing in British Columbia and Quebec 1208 patients started the questionnaire with 1180 completing responding to a non-digital game portion. 590 subjects responded to the digital portion Convenience sampling with	Questionnaire method to evaluate perceptions of seniors that play digital games ad to potential benefits of digital games	Questionnaire were administered in public areas. No comparison or control group	Seniors who play digital games have both cognitive and socioeconomic benefit, though cognitive benefits were more widely perceived than social benefits Limitations: Lack of ability to validate questionnaire, limited culture and age group,

	Setting: community centers, shopping malls and other public places			introduction of bias by selecting seniors in public areas which may have higher health status
Heinrich et al., (2012)	Sample: 674 total patients with Diabetes recruiting through ads in free diabetes magazine, door-to-door flyers, and two websites - with 99 subjects participating in pre and post-test design, 564 participating in post online participation questionnaire, and 11 subjects who participated in one-on-one interview Setting: Netherlands	Randomized Controlled Trial	A randomized control trial utilizing a diabetic simulation game to increase knowledge of Diabetes type 2, encourage active patient participation, provide tools to support adequate self-management by utilizing a pre-test and a post-test after two weeks . An experimental group, a control group and a post-test only control group (to assess for any completing of pre-test on post-test knowledge) was utilized.	Within the intervention group knowledge was significantly increased, there was no improvement in the control groups. Limitation: Limited time (2 weeks for patients to access simulation game, additionally low interview numbers post utilization many effect data. There was also little use of self-management portion of the digital game. There was a high number of non-responders to the user evaluation question however, the authors offered the large sample size was satisfactory to support their conclusions
Primack, et al., (2012)	Subjects: Patient number not noted	Literature search including MEDLINE, CINAHL, EMBASE, Cochrane	Randomized controlled style of 38 studies to review positive clinically	69% improvement in psychological therapy outcomes. 59% in physical therapy improvement outcomes. 50%

		Specify, center on media and child health data-base of research	relevant consequences of chronic illness using video games.	improvement of physical activity outcomes. 46% improvement in clinician skills outcomes. 42% improvement in health education outcomes. 42% improvement in pain management outcomes. 37% improvement in disease self-management outcomes. Limitations: Average study quality was generally poor with 66% of studies having less than 12 weeks of follow-up, with only 11% of studies having blinded researchers.
Radhakrishnan, et al., (2016)	Sample: 19 community residing older adults (beta testing) Six community residing older adults (usability testing) Setting: outpatient heart failure clinic (Austin, Texas)	Casino slot game genre with heart failure education adapted from Heart Failure Society of America evidence-based guidelines, tailored to low literacy levels.	Usability: guided observations, video tape observations with completion of usability survey (serious game usability evaluation and the intrinsic motivation inventory)	50% male, 50% females with 100% finding the game easy to play, 100% finding it enjoyable, and 83% found it helpful in heart failure education. Limitations: small sample size, limited to older adults, in community setting
Radhakrishnan, et al., (2016a)	Sample: 19 community residing adults with heart	Feasibility study	Observations of older heart failure	Heart Failure knowledge significantly

	failure (majority were male, Caucasian, older than 70 with heart failure diagnosis greater than 10 years) Setting: heart failure clinic (University of Texas Austin)		patients participating with pre and post-test design with validated instruments of the Atlanta Heart Failure Knowledge Test and the Self Care for Heart Failure Index	improved in pre and post testing ($p = 0.007$). Nonsignificant improvement in SCHFI pre and post testing ($p = 0.11$ and no change in heart failure self-efficacy heart failure scores). Continued use of enjoyability, usefulness and preferred learning method. Limitations: small sample size, lack of control group, short follow up time of four weeks, predominantly male population with lower education level, lack of true randomization as participation was voluntary.

Table 3
Heart Failure Coach Demographics

	n	%	Range	Mean (SD)
Gender	20			
Female	7	35		
Male	13	65		
Age			27 – 91	61.15 (15.58)
Race				
African American	3	15		
White	15	75		
Other	2	10		
Education				
Less than 12 years	2	10		
12 years complete	3	15		
College Complete	6	30		
Post Undergraduate Studies	9	45		
NYHA Class				
Class I	1	5		
Class II	0	--		
Class III	9	45		
Class IV	10	50		
New Diagnosis of Heart Failure				
Not new Diagnosis	15	75		
New Diagnosis	5	25		
Diabetes				
No History	11	55		
Positive History	9	45		
Hypertension				
No history	5	25		
Positive History	15	75		
Hyperlipidemia				
No history	6	30		
Positive History	14	70		
Played with support person				
No support person	14	70		
Played with spouse (minimal)	6	30		

Table 4
Patient Satisfaction Questionnaire – Likert Scale Items

Item	n	%	Range	Median	IQR
Weigh Daily			1-5	5	0
Agree	2	10			
Strongly Agree	18	90			
Medications			1-5	5	0
Agree	1	5			
Strongly Agree	19	95			
Salt Intake			1-5	5	0
Neutral	1	5			
Agree	5	25			
Strongly Agree	14	70			
Fluid Intake			1-5	5	0
Neutral	2	10			
Agree	6	30			
Strongly Agree	12	60			
Symptoms			1-5	5	0
Neutral	1	5			
Agree	4	20			
Strongly Agree	15	75			
Unsure Call			1-5	5	0
Disagree	1	5			
Neutral	1	5			
Agree	4	20			
Strongly Agree	14	70			
Worsen Call			1-5	5	0
Agree	2	10			
Strongly Agree	18	90			
Easibility			1-5	5	0
Agree	3	15			
Strongly Agree	17	85			
Likability			1-5	5	0
Neutral	1	5			
Agree	2	10			
Strongly Agree	17	85			

Table 5
Patient Satisfaction Questionnaire – Education Items

Item	n	%
Heart Failure Coach Education		
Self-Care Maintenance	5	25
Symptom Recognition	2	10
Self-Care Management	2	10
No Item Identified	11	55
Traditional Heart Failure Education		
Self-Care Maintenance	1	5
Symptom Recognition	2	10
Self-Care Management	-	--
No Item Identified	17	85
Additional TIGR videos		
Not Viewed	16	80
Viewed	4	20

Table 6

SCHFI Pre and Post Heart Failure Coach Game – Paired Samples T-Test

Item	Pre-Game Mean (n=20)	SD	Post- Game Mean (n=17)	SD	*t*	95% CI	p value
SCHFI Maintenance	57.28	± 18.20	73.00	± 9.07	-3.769	-24.58 - -6.88	0.002
SCHFI Confidence	56.54	± 20.81	82.03	± 10.67	-4.570	-25.49 - -13.67	<0.001

Note. HFC = Heart Failure Coach from SimCoach Heart Failure Coach Simulation Game; SCHFI = Self-Care in Heart Failure Index. From "Self-Care in Heart Failure Index Version 6.2," by Riegel, B., Lee, C., Dickson, V., & Carlson, B. (2009). An Update on the Self-Care of Heart Failure Index. *J Cardiovas Nurs. 24(6):* 485-497.

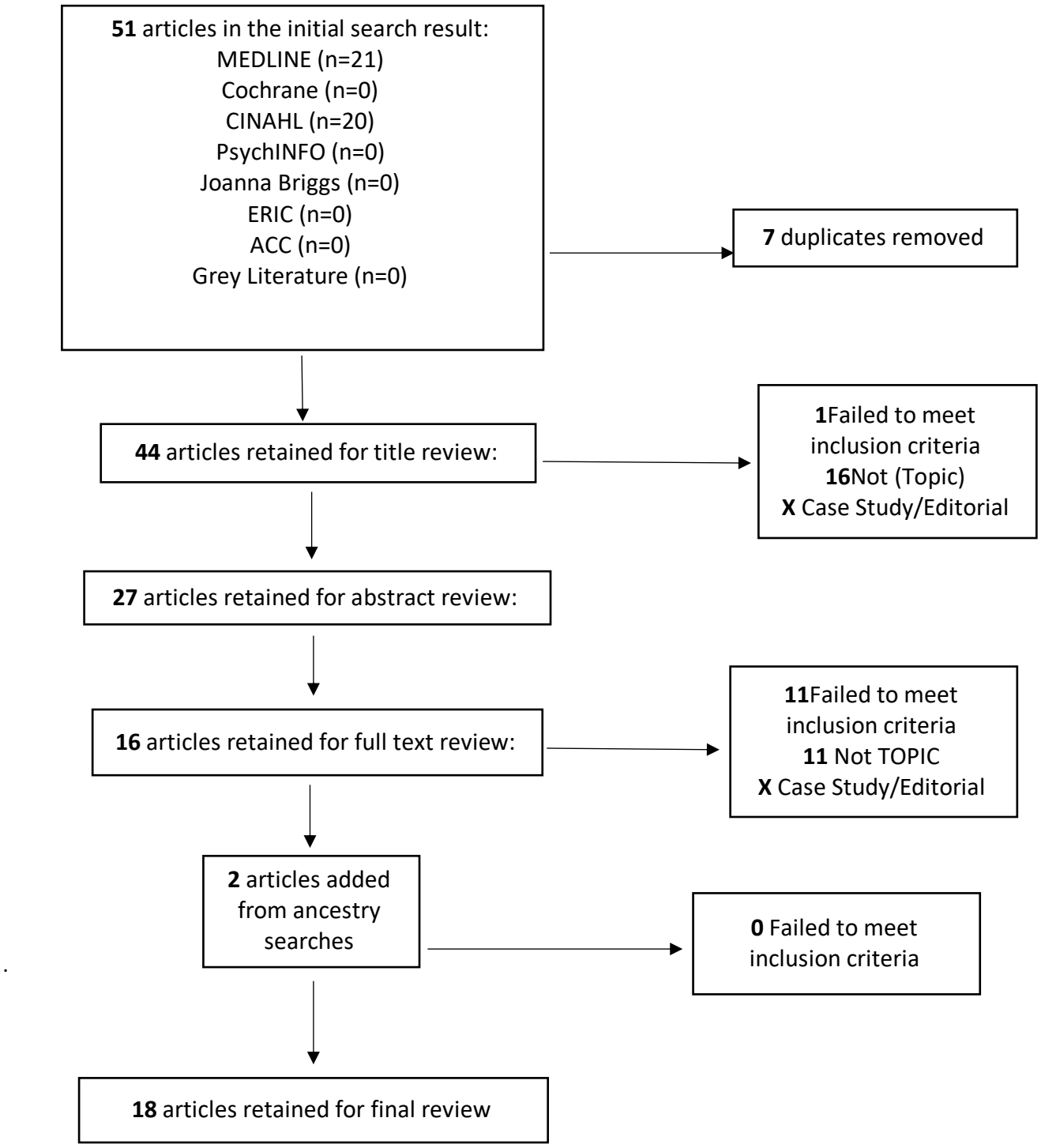

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Figure 1. *Literature Search Procedure for Heart Failure and Symptom Recognition*

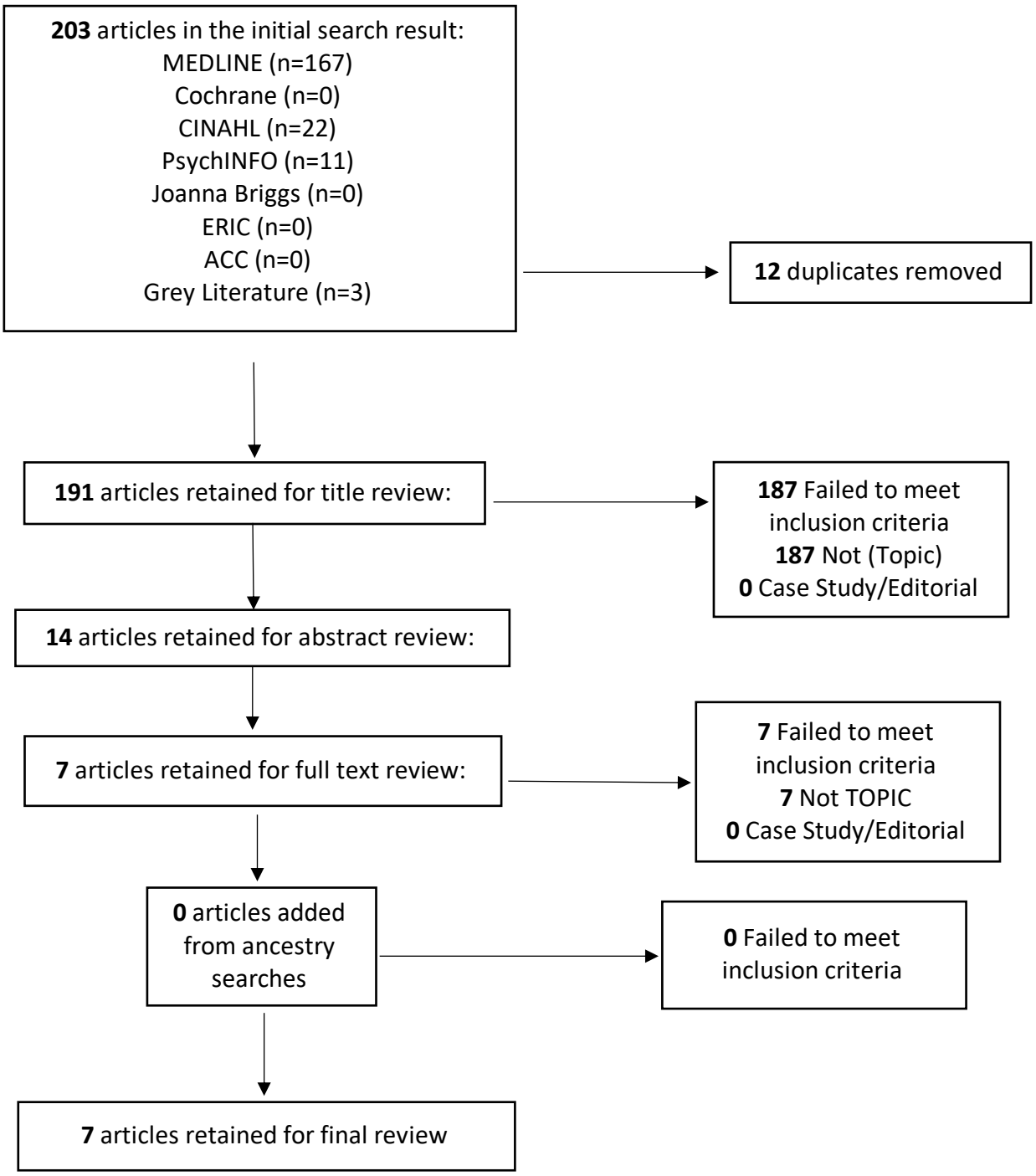

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Figure 2. *Literature Search Procedure for Heart Failure and Gamification*

Figure 3. The situation-specific theory of heart failure self-care, revised and updated. Riegel, B., Vaughan Dickson, V., & Faulkner, K. M. (2016). The situation-specific theory of heart failure self-care. Journal of Cardiovascular Nursing, 31(3), 226-235. doi:10.1097/JCN.0000000000000244

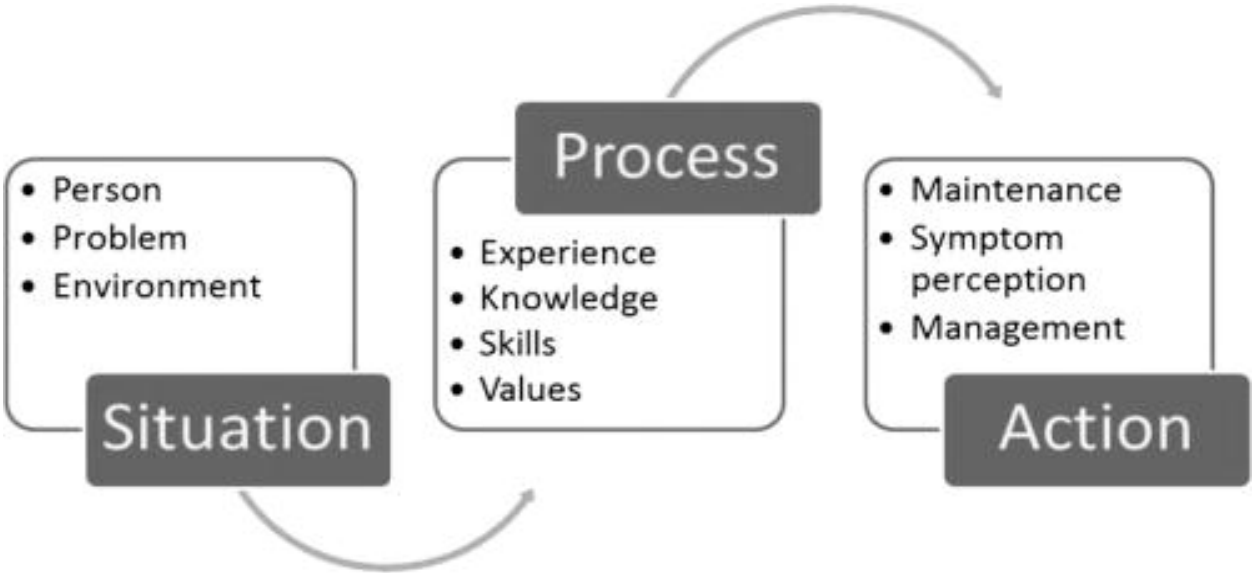

Figure 4. The situation-specific theory of heart failure self-care, revised and updated. Riegel, B., Vaughan Dickson, V., & Faulkner, K. M. (2016). The situation-specific theory of heart failure self-care. Journal of Cardiovascular Nursing, 31(3), 226-235. doi:10.1097/JCN.0000000000000244

Appendix A

Inova Healthcare System – IRB Approval Letter

From: do-not-reply@keyusa.com
Sent Date: Friday, October 05, 2018 07:40:58 AM
To: caw2pa@virginia.edu, Martha.Schneider@inova.org, maryann.friesen@inova.org, paula.wypych@inova.org
Cc:
Bcc: irb@inova.org
Subject: 18-3195 - Approval Letter
Message:

Ms. Wypych,

The initial submission for study "The Effects of Simulation of Heart Failure Self-Care Maintenance, Symptom Recognition, and Self-Care Management" has been approved.

The approved Informed Consent version 1 dated October 2018 has been saved to page 22 of the "Protocol Information" section and also attached.

The approved HIPAA Authorization is attached to page 25 of the "Protocol Information" section and also attached.

Also attached is "Helpful Hints for Managing Research Studies" to review as you conduct your study.

Please send an email to IRB@inova.org with any questions.

thank you,
Kathy Ababio
IRB Manager

Appendix B1

University of Virginia IRB Approval Page 1 of 4

UNIVERSITY of VIRGINIA IRB-HSR **Institutional Review Board for Health Sciences Research**

DETERMINATION OF UVa AGENT FORM

INFORMATION ABOUT THIS FORM

- This form is to determine if UVa personnel are or are not considered to be working as an Agent* for UVA on this project.
- If it is determined that UVA personnel are considered to be working as an Agent* for UVA the study, then your team will be required to provide an additional submission to the IRB-HSR, unless the project is determined to not involve human subject research. See Determination of Human Subject Research Form

***Agent-** all individuals (including students) performing institutionally designated activities or exercising institutionally delegated authority or responsibility.*

Enter responses electronically. Email the completed form to IRBHSR@virginia.edu for pre-review. An IRB staff member will reply with any changes to be made.

Name of Individual to be Working on Project:	Paula K. Wypych, MS, AGACNP-BC, FNP-BC, CCRN
UVA Email:	pkw7u@virginia.edu
Phone:	703-201-9365
UVa Messenger Mail Box #	N/A
Project/Protocol Title if Known:	☐ Unknown or Title: The Effects of Simulation in Heart Failure Self-Care Maintenance, Symptom Recognition, and Self-Care Management
List your UVA School or Department affiliation *(e.g. Nursing, Medicine, etc.)*	Nursing - Graduate Studies
Name of the Division *(if applicable)* *(e.g. Anesthesia, Graduate Studies etc.)*	
Explain your role in the project: (200 words or less)	I will be the principal investigator employing the use of video game simulation with heart failure patients to study the effect on patient self-care maintenance, symptom regcognition and self-care management. I will be conducting the majority of the study after they have received routine heart failure education while they are in the hospital. This will include the of Riegel's Self-care in Heart Failure index pre-simulation, they "playing" of the video game Heart Failure Coach, followed by a patient satisfaction questionnaire post the completion of the game. A one-time brief (less than 5 minute) phone interview will occur one week after they leave the hospital. During this interview, Riegel's Self-Care in Heart Failure Index will be used agin. Data will be collected and analyzed.
Explain the reason for traveling to the outside institution.	I am currently employed and on house staff at Inova Heart and Vascular Institute, and will be completing my

Appendix B2
University of Virginia IRB Approval Page 2 of 4

Scholarly project at Inova Heart and Vascular Institute

Appendix B-3

University of Virginia IRB Approval Page 3 of 4

INSTRUCTIONS: Complete the applicable option below:

Option A: Typically used by UVA personnel who are asked to assist with a research study after arriving at the non- UVA institution. (e.g., resident doing rotation at another institution)

Answer the following questions:

☐Yes ☐No I was involved in the design of this research project.
☐Yes ☐No A UVA IRB has approved this research. IRB-HSR/UVA Study Tracking # 18-3195
☐Yes ☒No Funding to conduct this research will come from or through UVa.
☐Yes ☐No Working on this research is required for my degree program.

I confirm that:

☐Yes ☐No I am a student, employee or faculty member of the University of Virginia.
☐Yes ☐No My work on this project will be overseen by the Principal Investigator and the IRB at the outside institution. This includes completing any training in human subject research protection or other training as required by the outside IRB.
☐Yes ☐No I will communicate with the UVA IRB and UVA Contracts Office for my school, to determine what approvals may be needed, prior to receiving any data from the outside institution

Option B: Typically used by graduate students conducting their research outside of UVA.

I confirm that:

☒Yes ☐No I designed this research.
☒Yes ☐No I am a student, employee or faculty member of UVa but am employed by another institution.
☒Yes ☐No All subjects will be enrolled at this outside institution.
☒Yes ☐No Only de-identified data may be brought to UVA. If data is brought to UVA it will be protected according to UVA Data Security Policies.
☒Yes ☐No The research will be overseen by their IRB and, if applicable, their HIPAA Privacy Board. This includes completing any training in human subject research protections or other training as required by the outside IRB.
☒Yes ☐No There is no funding for this study or if there is funding, it will be handled by the non-UVA institution at which I am employed.
☒Yes ☐No I have notified the outside IRB that a UVA IRB will not be overseeing my work. ATTACH COPY OF THE OUTSIDE IRB APPROVAL/DETERMINATION.

Appendix B4
University of Virginia IRB Approval Page 4 of 4

Option C: Typically used by a person who will continue working on their research at their previous institution after transferring to UVA. No research protocol will be opened to enroll additional subjects at UVA.

I confirm that:

☐Yes ☐No I am a student, employee or faculty member of UVa but I was employed by another institution when the research was begun.

☐Yes ☐No All subjects were or will be enrolled at the outside institution & all data will remain there.

☐Yes ☐No The research will be overseen by a non-UVA IRB and, if applicable, the HIPAA Privacy Board of my previous institution. This includes completing training in human subject research protections or other training as required by the outside institution.

☐Yes ☐No There is no funding for this study or if there is funding, it will be handled by my previous institution.

☐Yes ☐No I have notified the IRB of Record that I have transferred to UVA and that a UVA IRB will not be overseeing my work on this research protocol.
ATTACH COPY OF THE OUTSIDE IRB APPROVAL/DETERMINATION.

Option D: Typically used by a UVa Faculty member who has an appointment or clinical privileges at another institution. Research to be conducted at outside institution. Research protocol will not be opened to enroll subjects at UVA facilities.

I confirm that:

☐Yes ☐No I am a faculty member of UVA and I have an appointment or clinical privileges at another institution.

☐Yes ☐No All subjects will be enrolled at the other institution and all data will remain there.

☐Yes ☐No The research will be overseen by a non-UVA IRB and, if applicable, the HIPAA Privacy Board of the other institution. This includes completing any training in human subject research protections or other training as required by the other institution.

☐Yes ☐No There is no funding for this study or if there is funding, it will be handled by the other institution.

☐Yes ☐No I have notified the IRB of Record that a UVA IRB will not be overseeing my work on this research protocol.
ATTACH COPY OF THE OUTSIDE IRB APPROVAL/DETERMINATION for this protocol.

FOR IRB-HSR OFFICE USE ONLY

☐ UVa personnel are not considered to be working as an Agent for UVa on this project.
No approvals from the UVa IRB-HSR are required.
UVA Study Tracking #

☐ UVa personnel are considered to be working as an Agent for UVa on this project.
Submit a research application to the UVa IRB-HSR.

Signature of IRB Chair, Director or Designee Date

Appendix C
Approval of Settings – Inova Healthcare System

RE: Next steps

Friesen, Mary Ann

You replied to this message on 6/30/2018 6:27 PM.

Sent: Tue 6/26/2018 8:12 AM
To: Schneider, Martha; Wypych, Paula
Retention Policy: Default All Other Folders - Delete 183 Days (6 months) Expires: 12/26/2018

Hi Paula,
Great to hear you are moving through the process for your DNP Project.
Have you been able to complete your WCG training so you can obtain an e-protocol number?
You will need an e-protocol number is order to complete the IRB submission to Inova.
Best wishes for great success at your proposal defense.
Looking forward to speaking with you and Martha in July or Aug.
Best regards,

Mary Ann Friesen PhD, RN, CPHQ
Nursing Research and Evidence Based Practice Coordinator
Professional Practice
Inova System Office
8110 Gatehouse Road, Suite 600 West
Falls Church ,VA 22042
T 703-205-2135 |F 703-205-2380 |

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Appendix D

CITI Training Certification

CITI PROGRAM

Completion Date 22-Apr-2018
Expiration Date 21-Apr-2021
Record ID 26882832

This is to certify that:

Paula Wypych

Has completed the following CITI Program course:

Human Research (Curriculum Group)
IRB for Health Sciences Research (IRB-HSR): ALL RESEARCH (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Virginia

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wf1a42692-8b4d-4b50-af07-6595c3fdc769-26882832

Appendix E

WCG (WIRB Copernicus Group) Training Certifications

wcg™ WIRB COPERNICUS GROUP®

Certificate of Completion

Paula Wypych
Investigator Obligations (WCG_Investigator_Investigator_Obligations Ver 1.0)

Friday, June 22, 2018

COURSE CODE
WCG_Investigator_Investigator_Obligations

TRAINING TYPE
Computer Based Training - Mastery

CERTIFICATE NUMBER
31922218

wcg™ WIRB COPERNICUS GROUP®

Appendix F
Permission for use Simcoach – Heart Failure Coach

simcoachGAMES

July 7, 2018

To whom it may concern,

In having purchased and downloaded Heart Failure Coach app(s) from a mobile app store, Paula Wypych has the consent of Simcoach Games to use this mobile application as is in her doctoral research study for the University of Virginia. We hope Ms. Wypych will share the results of her study with us and expect that she will credit Simcoach Games and UPMC appropriately in anything published.

Regards,

Anthony Zabiegalski
Vice President, Production
Simcoach Games
412.246.4020
azab@simcoachgames.com

Appendix G
Approval from the University of Pittsburgh Medical Center

UPMC LIFE CHANGING MEDICINE

July 6, 2018
To Whom it May Concern:

On behalf of UPMC I am pleased to offer support for the use of SimCoach and its related data by Paula Wypych in her doctoral research study for the University of Virginia.

We look forward to receiving the results of the study and request that UPMC be acknowledged in any forthcoming publications.

Sincerely,

Amy Ranier, Senior Director

Wolff Center for Quality at UPMC 4601 Baum Boulevard, Suite 232 Pittsburgh, Pennsylvania 15213

Appendix H

Heart Failure Coach Demographic Data Collection Sheet

HEART FAILURE COACH DEMOGRAPHIC INFORMATION

AGE _____

GENDER FEMALE MALE

RACE / ETHNICITY

____AFRICAN AMERICAN / BLACK

____ASIAN

____HISPANIC

____WHITE

____OTHER

EDUCATION LEVEL

____LESS THAN GRADE 12

____COMPLETETED GRADE 12

____COMPLETED UNDERGRADUATE DEGREE

____POST UNDERGRADUATE DEGREE

NYHA SYMPTOM LEVEL **I** **II** **III** **IV**

NEW DIAGNOSIS OF HEART FAILURE YES NO

COMORBIDITIES:

DIABETES YES NO

HYPERTENSION YES NO

DYSLIPIDEMIA YES NO

PLAYED WITH SUPPORT PERSON YES NO

Appendix I
Self-Care in Heart Failure Index

SELF-CARE OF HEART FAILURE INDEX

All answers are confidential.

Think about how you have been feeling in the last week or since we last spoke as you complete these items.

SECTION A:
Listed below are common instructions given to persons with heart failure. How routinely do you do the following?

	Never or rarely	Sometime	Frequently	Always or daily
1. Weigh yourself?	1	2	3	4
1. Check your ankles for swelling?	1	2	3	4
1. Try to avoid getting sick (e.g., flu shot, avoid ill people)?	1	2	3	4
1. Do some physical activity?	1	2	3	4
1. Keep doctor or nurse appointments?	1	2	3	4
1. Eat a low salt diet?	1	2	3	4
1. Exercise for 30 minutes?	1	2	3	4
1. Forget to take one of your medicines?	1	2	3	4
1. Ask for low salt items when eating out or visiting others?	1	2	3	4
1. Use a system (pill box, reminders) to help you remember your medicines?	1	2	3	4

SECTION B:

Many patients have symptoms due to their heart failure. Trouble breathing and ankle swelling are common symptoms of heart failure.

In the past week, have you had trouble breathing or ankle swelling? Circle one.

1. No
2. Yes

1. If you had trouble breathing or ankle swelling in the past week…

(circle **one** number)

	Have not had these	I did not recognize it	Not Quickly	Somewhat Quickly	Quickly	Very Quickly
How quickly did you recognize it as a symptom of heart failure?	N/A	0	1	2	3	4

Listed below are remedies that people with heart failure use. If you have trouble breathing or ankle swelling, how likely are you to try one of these remedies?

(circle **one** number for each remedy)

	Not Likely	Somewhat Likely	Likely	Very Likely
1. Reduce the salt in your diet	1	2	3	4
1. Reduce your fluid intake	1	2	3	4
1. Take an extra water pill	1	2	3	4
1. Call your doctor or nurse for guidance	1	2	3	4

1. Think of a remedy you tried the last time you had trouble breathing or ankle swelling,

(circle **one** number)

	I did not try anything	Not Sure	Somewhat Sure	Sure	Very Sure
How sure were you that the remedy helped or did not help?	0	1	2	3	4

SECTION C:

In general, how confident are you that you can:

	Not Confident	Somewhat Confident	Very Confident	Extremely Confident
1. Keep yourself free of heart failure symptoms?	1	2	3	4
1. Follow the treatment advice you have been given?	1	2	3	4
1. Evaluate the importance of your symptoms?	1	2	3	4
1. Recognize changes in your health if they occur?	1	2	3	4
1. Do something that will relieve your symptoms?	1	2	3	4
1. Evaluate how well a remedy works?	1	2	3	4

Appendix J

Patient Satisfaction Survey Post Heart Failure Coach Completion

QUESTION	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
HEART FAILURE COACH HELPED ME UNDERSTAND IT IS IMPORTANT TO …….					
WEIGH EACH MORNING					
TAKE MY MEDICINES JUST AS MY PROVIDER TOLD ME TO					
WATCH HOW MUCH SALT I HAVE EVERY DAY					
WATCH HOW MUCH LIQUID I DRINK IN A DAY					
KNOW THE SIGNS OF MY HEART FAILURE MAY BE GETTING WORSE					
CALL A NURSE OR DOCTOR IF I AM NOT SURE IF MY HEART FAILURE IS GETTING WORSE					
CALL MY PROVIDER IF MY HEART FAILURE IS GETTING WORSE					

PLEASE ANSWER THE FOLLOWING QUESTIONS:

I FOUND HEART FAILURE COACH EASY TO USE					
I LIKED PLAYING HEART FAILURE COACH					

I WISH THE HEART FAILURE COACH TALKED ABOUT:

I WISH I HAD MORE INFORMATION ABOUT:

I WATCHED ADDITIONAL TIGR HEART FAILURE VIDEOS OTHER THAN WHAT I VIEWED WITH THE PATIENT CARE NAVIGATOR (PLEASE CIRCLE)

YES NO

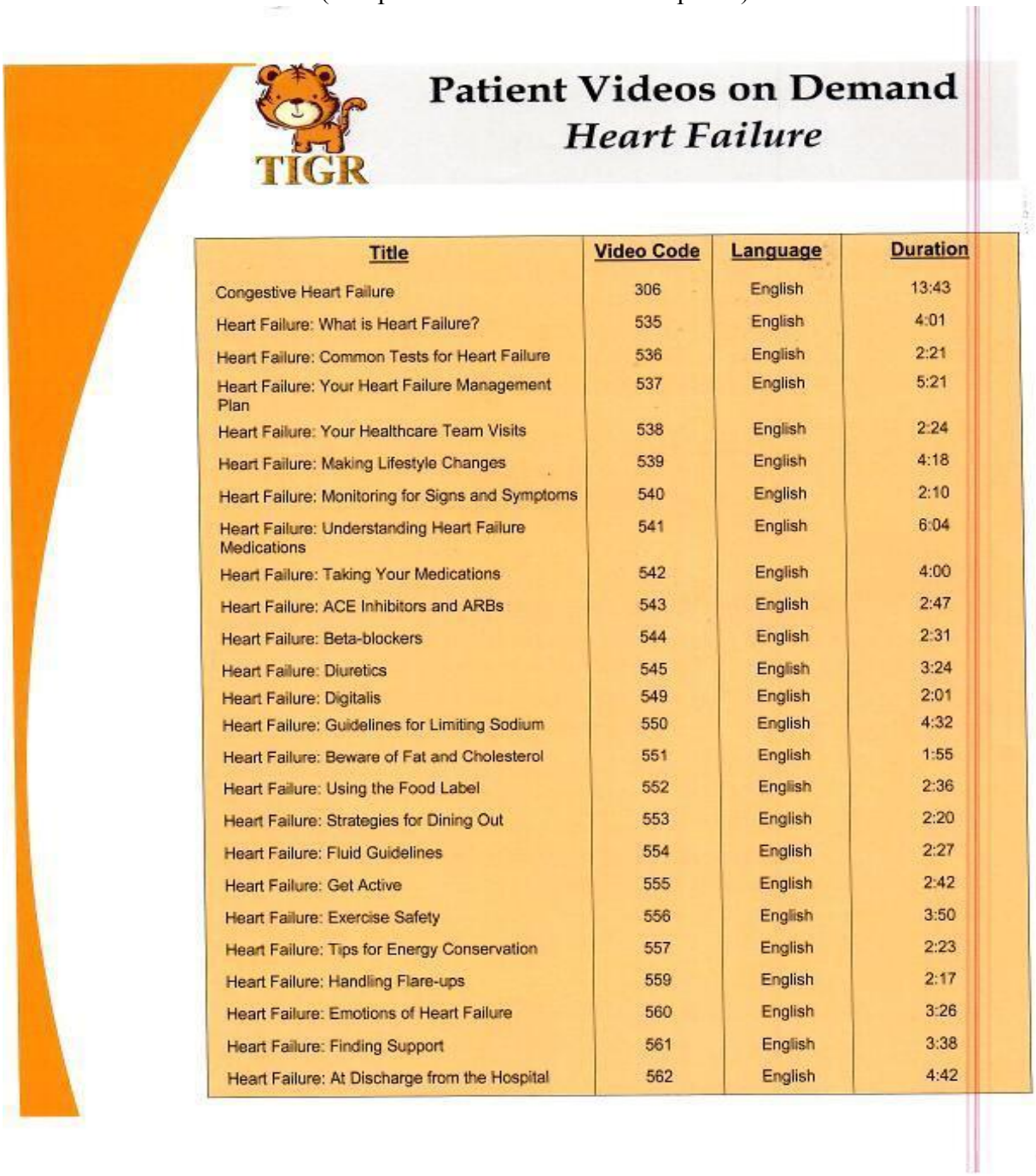
Appendix K

Krames Patient Education: Living Well with Heart Failure -Table of Contents

This book will help you understand and follow your heart failure treatment plan. The first six chapters can be read in any order. The seventh chapter provides tools to help you manage your health. You may want to share this book with family, friends, and caregivers.

Appendix L

TIGR♥ (Telephone Initiated Guided Response) Videos



Title	Video Code	Language	Duration
Congestive Heart Failure	306	English	13:43
Heart Failure: What is Heart Failure?	535	English	4:01
Heart Failure: Common Tests for Heart Failure	536	English	2:21
Heart Failure: Your Heart Failure Management Plan	537	English	5:21
Heart Failure: Your Healthcare Team Visits	538	English	2:24
Heart Failure: Making Lifestyle Changes	539	English	4:18
Heart Failure: Monitoring for Signs and Symptoms	540	English	2:10
Heart Failure: Understanding Heart Failure Medications	541	English	6:04
Heart Failure: Taking Your Medications	542	English	4:00
Heart Failure: ACE Inhibitors and ARBs	543	English	2:47
Heart Failure: Beta-blockers	544	English	2:31
Heart Failure: Diuretics	545	English	3:24
Heart Failure: Digitalis	549	English	2:01
Heart Failure: Guidelines for Limiting Sodium	550	English	4:32
Heart Failure: Beware of Fat and Cholesterol	551	English	1:55
Heart Failure: Using the Food Label	552	English	2:36
Heart Failure: Strategies for Dining Out	553	English	2:20
Heart Failure: Fluid Guidelines	554	English	2:27
Heart Failure: Get Active	555	English	2:42
Heart Failure: Exercise Safety	556	English	3:50
Heart Failure: Tips for Energy Conservation	557	English	2:23
Heart Failure: Handling Flare-ups	559	English	2:17
Heart Failure: Emotions of Heart Failure	560	English	3:26
Heart Failure: Finding Support	561	English	3:38
Heart Failure: At Discharge from the Hospital	562	English	4:42

Appendix M

Managing Your Heart Failure Using the Zones

Appendix N
Laminated Reminder Card

Thanks for Participating in
The Heart Failure Coach Video Game Study

THIS IS A REMINDER CARD

- You will be called one week after you leave the hospital for a one- time phone interview
- It is anticipated to take no more than 5 minutes

If you have questions about this study, or wish to withdraw, contact paula.wypych@inova.org

If You Have Symptoms – Call Your Doctor

Appendix O

Draft Manuscript for Publication Submission to Journal of Cardiovascular Nursing

The Effect of Gamification on Heart Failure Self-Care

Paula Wypych, DNP, AGACNP-BC, FNP-BC

Clareen Wiencek, PhD, ACNP, ACHPN

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ABSTRACT

Background: Increasing patient knowledge has been a focus to improve heart failure self-care; despite many modalities to improve knowledge readmission rates remain unchanged. Gamification has been used successfully in diabetes and asthma to foster self-care, but little has been studied with the use of gamification and its impact on heart failure self-care.

Objective: To study the effect of gamification on heart failure self-care.

Methods: This study utilized a quasi-experimental design. On an advanced heart failure unit, after traditional heart failure education, 20 patients were administered the SCHFI v. 6.2 prior to playing the Heart Failure Coach, a heart failure simulation game to reinforce activities of heart failure self-care. This was followed by a patient satisfaction questionnaire. One week post-discharge the SCHFI was re-administered, with pre and post SCHFI analysis completed.

Results: There was a significant increase in self-care maintenance and self-care confidence on the SCHFI ($t= -3.769$ [CI -24.58 - -6.88], $p < .002$ and $t = -4.570$ [CI -25.49 - -13.67], $p < .001$ respectively). Due to lack of symptoms, follow up SCHFI self-care management scores could not be assessed. Greater than 90% of patients were satisfied with the Heart Failure Coach, and it was a preferred mean of education over traditional heart failure education.

Conclusions: Gamification with the Heart Failure Coach, showed a positive impact on heart failure self-care maintenance and confidence. Patients reported that the Heart Failure Coach was easy to use, well liked, and provided a simulated learning environment.

Key Words: Heart failure, self-care, gamification

INTRODUCTION

Heart failure rates continue to increase, with 800,000 newly diagnosed patients over the past eight years.[1] It is anticipated that 8.1 million people will be affected by 2030 which has significant impact on personal and financial levels.[2] Despite guidelines in place since 2005, only few hospitals have seen a decrease in readmissions and heart failure self-care has come into focus as a means to alleviate morbidity and cost.[3]

Heart Failure Self-care

Heart failure patients and their caregivers have been charged with the tasks of medication knowledge, awareness of symptoms, seeking help for symptoms or managing their symptoms when troublesome.[4] Emphasis has been placed on patient education to help achieve these goals and minimize readmissions with heart failure.[4] Educational teaching strategies such as teach-back, heart failure diaries, and videos have also been utilized with improvement in patient knowledge levels; however, the rates of readmission have remained virtually unchanged.[5,6] More recently, some studies report that while patient and caregiver knowledge can be adequate, recognizing symptoms and implementing actions to alleviate symptoms are not taken by the heart failure patients.[5,7,8]

In a systematic review by Clark et al.[7] heart failure patients' symptoms were found to be similar to symptoms of other chronic conditions and that patients could not discern acute change. The role of a consistent support person helped patients recognize symptoms and prompted care seeking behavior.[7] However even when patients sought care, they had difficulty accessing a provider to help with symptom assessment and /or management .[7] Riegel et al.[4] in the Situation Specific Theory of Heart Failure Self-care hypothesize that for patients to be successful, the actions of self-care maintenance, symptom recognition and self-care management

must be in play. This occurs not through linear thinking but through Naturalistic Decision Making (NDM).[4] NDM incorporates patients' situation (e.g. knowledge, environment) and process (e.g. prior management experiences and values) in navigating heart failure self-care.[4] Educating patients in heart failure self-care is essential, but providing them the opportunity to process and practice heart failure self-care prior to hospital discharge may prove valuable.

The Role of Heart Failure Gamification

In other chronic conditions, like diabetes or asthma, simulation games have successfully been used to reinforce knowledge, assess symptoms, and formalize plans for self-management.[9] Little is known regarding the impact of heart failure gamification on self-care behaviors. Only one study was found that measured the usability and likability of gamification on outpatient seniors with heart failure.[10] There is a gap in knowledge of the role that gamification may have in heart failure self-care.

Research Question

The purpose of this study was to determine the effect of heart failure gamification on heart failure self-care in patients recently discharged with a heart failure diagnosis.

METHODS

Design and Setting

This study employed a quasi-experimental design. It took place in a 923 tertiary care community hospital on an advanced heart failure unit.

Sample

The sample consisted of patients with the primary diagnosis of heart failure who were hospitalized on the study unit and had completed traditional heart failure education provided by

the patient care navigator. Inclusion criteria were patients admitted with a primary or secondary diagnosis of heart failure over the age of 18. Exclusion criteria included psychoneurological disorders impacting cognition (such as documented dementia or delirium), inability to understand spoken or written English and respond to English language questions, and inability to complete the Heart Failure Coach simulation game with more than minimal assistance.

Intervention

Approval from the Institutional Review Board was obtained. All heart failure patients admitted to the unit received traditional heart failure education by an RN who served as the unit's patient care navigator. This traditional education consisted of three components: Krames' patient education manual entitled, Living with Heart Failure©[11], viewing the TIGR© video entitled, Congestive Heart Failure[12], and individualized education by the navigator utilizing a symptomatic recognition tool by severity zone approach.

The patient census was screened by the researcher, and those patients meeting inclusion criteria were approached for participation by the researcher. After completion of traditional heart failure coach education by the patient care navigator and consent was obtained, patients completed demographic data collection and the Self-care in Heart Failure Index v 6.2 (SCHFI). Patients were introduced to The Heart Failure Coach game on the researcher's iPad. The researcher demonstrated use of the Heart Failure Coach game. This game was developed by SimCoach, a technology company that develops simulation games to be utilized in healthcare, and the University of Pittsburgh Medical Center (UPMC). The game shows Simon as a virtual patient recently discharged from the hospital and patients were asked to help Simon perform heart failure self-care such as daily weights, dietary sodium and fluid restriction, and medication

compliance. Patients were also asked to assess Simon's symptoms, and help devise a management plan for those symptoms. At the conclusion of the simulation, patients were informed how successful they had been at keeping Simon healthy. Areas to improve were identified by the Heart Failure Coach, and just in time education was provided by the researcher. The game took approximately 20 minutes to complete. If the patient had a support person present during the game, the support person was invited to participate in answering the questions posed during the playing of the game. The researcher tracked if a significant other participated in the game, as well as the relationship of the significant other. The patient was required to activate the response button. The patient then completed a 12-item patient satisfaction questionnaire. The researcher provided a laminated reminder card with pictures of the Heart Failure Coach and the researcher to the patient. The card served as a reminder to the patient that the researcher would contact the patient by phone in one week after their discharge and provided the researcher's practice setting email.

The researcher called each patient one week post-discharge to complete a follow-up SCHFI questionnaire. If the patient was not reachable, by first attempt, the researcher left a voice-mail message if possible. The message reminded the patient that the researcher was calling to complete the questionnaire and provided the researcher's healthcare system email if they wish to set a time for a return phone call. If the patient was unavailable, the researcher attempted to contact the patient two additional times in 48 -hour intervals and left an identical message. If there was no patient response, the patient was coded as lost to follow up. If the patient was assessed as having possible signs or symptoms of heart failure during the follow up phone interview, the patient was instructed to contact their cardiologist for further evaluation.

Measurement

Self-Care in Heart Failure Index utilized in this study was version 6.2. It contains 22 questions, 10 questions pertaining to self-care maintenance, six questions pertaining to self-care management or symptom recognition, and six questions pertaining to self-care confidence.

Patient Satisfaction Questionnaire was a Likert based survey with items written by the researcher at a primary reading level and a clinical expert validated the content. It measured ease of use and likability of the Heart Failure Coach game, benefit derived in heart failure self-care maintenance, symptoms recognition, and self-care management. Additionally, the patient was asked in open-ended format what information they would have liked the Heart Failure Coach to have included, and if there was any further information they would like to receive. Data about additional TIGR heart failure videos©[12] viewed by the patient was also collected.

Data analysis

Data was analyzed using SPSS version 25 software. Descriptive statistics were used for demographic data and the patient satisfaction questionnaire. The pre and post SCHFI were analyzed using paired t-testing.

RESULTS

This study was implemented over a two month period in late 2018. 107 patients were screened and 68 were excluded. Of these 68, 33 were excluded due to psychoneurological criteria of delirium or dementia, four patients did not speak English, 19 did have the primary diagnosis of heart failure but were being evaluated for heart transplant or left ventricular assist device, three enrolled in hospice and nine had not yet received tradition education from the navigator. Nineteen patients refused to participated in the study. This resulted in a sample of 20

that were enrolled in the study. Two patients were lost to follow up and one died. Seventeen patients completed the study.

The patients ages ranged from 27-91 years with a mean age of 61.15 years (SD = 15.58), predominantly male (65%) and white (75%). Thirty percent of the patients completed college and 45% completed post graduate studies. Forty-five percent of the patients had NYHA functional Class III heart failure, and 50% had NYHA functional Class IV heart failure. Only 25% were admitted with a new diagnosis of heart failure. Prior history of diabetes, hypertension and hyperlipidemia was 45%, 75% and 70% respectively. Six patients (30%) played the Heart Failure Coach game with a support person present who was their spouse. (See Table 1 for demographic characteristics).

Descriptive statistics for the patient satisfaction questionnaire revealed 90-100% of patients agreed or strongly agreed that the Heat Failure Coach was helpful with recognizing the importance of daily weights, medication adherence, dietary sodium intake, fluid restriction, and calling a provider if symptoms worsen. One hundred percent of respondents agreed or strongly agreed that the Heart Failure Coach was easy to play, and 95% of patients agreed or strongly agreed they liked the Heart Failure Coach (See Table 2 for descriptive statistics, usability and satisfaction responses).

Nine of the 20 patients (45%) listed education items they would like additionally addressed by the Heart Failure Coach; five areas addressed self-care maintenance, two addressed symptom recognition and two addressed self-care management (See Table 3). Three patients (15%) listed education items they would like covered by traditional education; one item addressed self-care maintenance and 2 items addressed symptom recognition. Just four patients (20%) had viewed additional TIGR education videos. (See Table 3).

Mean pre-Heart Failure Coach SCHFI and post- Heart Failure Coach SCHFI scores for self-care maintenance were 57.28 ± 18.20 and 73.00 ± 9.07 respectively. This reflected an increase in 15.72 (t = -3.769, CI 95% [-24.58 - -6.88], p = 0.002). Mean pre-Heart Failure Coach SCHFI and post-Heart Failure Coach SCHFI scores for confidence were 56.56 ± 20.81 and 82.03 ± 10.67 respectively. This reflected an increase of 25.49 (t = - 4.570, CI 95% [-25.49 - -13.67], p < 0.001). (See Table 4 for pre and post test results). Only three patients experienced symptoms of shortness of breath or ankle swelling in the week after hospital discharge. According to the SCHFI scoring directions, the subscale in self-care management is not used unless patients have symptoms. Given the small number of patients (n=three), statistical analysis was precluded in the self-care management subscale.

DISCUSSION

The study sample was predominantly male, white, well educated, and most carried a prior diagnosis of heart failure as NYHA class III or IV heart failure. The patients demonstrated significant improvement in SCHFI self-care maintenance and self-care confidence subscale scores after participation in heart failure gamification. These findings were consistent with Lee and Riegel's[13] prior work, that found prior hospitalization, higher level of education, poorer functional status facilitated self-care symptom recognition. These findings occurred despite that patients in this study were older, and most carried co-morbidities, which Lee and Riegel found made symptom recognition difficult.[13]

Self-care Outcomes

The increase in self-maintenance subscale scores after completion of the Heart Failure Coach were comparable to outcomes due to nurse driven education in other studies. Three studies were found that added an educational intervention to traditional heart failure education

similar to this study's intervention. However, none used gamification. Awoke, Baptiste, Davidson, Roberts and Dennison-Himmelfarb[14] studied the effect of a nurse-led education program on knowledge, self-care, and readmission rates in 29 patients admitted for heart failure. Their sample demographics were similar to the demographics of this study in age, gender, and NYHA class with an average age of 66 years, 52% male, 35% Caucasian, 62% African American and 69% with NYHA class III or IV.[14] Patients baseline SCHFI scores were obtained before, at seven days and 30 days after the provision of nurse-led inpatient heart failure education. This nurse-led heart failure education incorporated the 2013 guidelines from the American College of Cardiology Foundation and American Heart Association for dietary and fluid restrictions, medication compliance, smoking cessation and compliance with follow up care.[12] Patients were then provided a symptom recognition and management guide based on their symptom severity zone. Self-care maintenance scores were improved at 7 days ($p \leq .000$) and 30 days ($p \leq .000$).[14]

Similar findings were echoed by Liou, Chen, Hsu, Lee, Chang, and Wu[15] in their study of a heart failure self-care program of 133 Taiwanese patients admitted with heart failure and randomized to standard heart failure education or self-care heart failure education. The standard heart failure education group received education that focused on heart failure symptoms and compliance to treatment. The self-care heart failure education group received a booklet, viewed a heart failure video, and received a day long individualized self-care education session focusing on medication compliance, dietary sodium and fluid restriction, lifestyle changes, exercise, and symptom assessment and management. Their reported demographics were an average age of 62 for both groups , predominantly male (77% standard group, 55% self-care group), NYHA III (44% standard, 54% self-care) and no NYHA IV patients in the study. Baseline SCHFI scores

were obtained the SCHFI was re-administered by phone seven- and thirty-days post discharge (Liou et al., 2015).[15] They found significant improvement in self-care maintenance at seven days and at the thirty-day post discharge utilizing SCHFI assessment ($p < .05$ and $p < .001$ respectively). These studies suggest that nurse-led self-care education may have a positive impact on self-care reports post heart failure hospitalization.[14,15]

In this study the improved self-care maintenance scores may additionally be due to the interactive approach which promoted active learning of self-care maintenance activities (daily weights, medication compliance, dietary sodium intake and fluid restriction) by utilization of real-life scenarios to reinforce the importance of consistency with this care. Stromberg, Ahlen, Fridlund, and Dahlstrom[16] found similar findings when they utilized interactive heart failure education. Stromberg, et al. utilized a CD-ROM program with eight modules, seven providing education in areas of heart failure, physiology, symptoms, diagnosis, medications, self-care and frequent questions.[16] The last module was a self-test that employed visual and auditory reinforcement during the testing. Stromberg et al. found that computer-based heart failure education was interactive, flexible and patients found it a preferred method of learning than written education or viewing videos.[16]

Self -care confidence scores also significantly increased after participation in the Heart Failure Coach consistent with other studies of heart failure patients after discharge. Awoke et al.[14] reported significant increase in self-care confidence scores the 30-day time point but not at seven-day. Liou, et al.[15] had similar findings in self-care confidence at both seven-day ($p < .05$) and 30-day (add the statistic add the t test $p < .05$) follow up assessment Vellone, Pancani, Greco, Steca, and Riegel[17] found that self-care confidence was an important factor in heart failure patients, particularly with cognition deficits. Vellone, et al.[17] explored the effect of self-

care confidence in mediating the relationship between attention and heart failure self-care, as well as the relationship between working memory and heart failure self-care. They called for further studies exploring interventions that improved self-care confidence over cognition in heart failure patients.[17]

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The improvement in the self-care confidence scores after completing the Heart Failure Coach in this study may reflect that the patients were put in simulated situations, and asked to assess symptoms and make an appropriate plan e.g. to call a provider or take an additional diuretic. This simulation may have led to increased retention of facts related to managing their heart failure. Additionally, the Heart Failure Coach afforded patients the opportunity to work through symptom recognition processes and plan with a support person, which also may reinforce their self-care behaviors and increased self-care confidence.

The self-care management subscale of the SCHFI was completed by all patients prior to playing the Heart Failure Coach game. Statistical analysis was not completed due to the low number of patients ($n = 3$) that experienced symptoms one week after hospitalization. Following the SCHFI v. 6.2 scoring guideline, self-care management subscale scores are not to be analyzed unless symptoms occur. In previous studies, Awoke et al. reported statistically significant findings in self-care management with SCHFI assessment follow up at 7 days ($p < .001$) and at 30 days ($p < .013$).[14] Liou et al. found statistical significance at 7 days and 30 days, in their

follow up SCHFI assessments ($p < .05$ and $p < .01$ respectively).[15] Symptom recognition could also not be analyzed in this study, as it was incorporated as part of the self-care management scale. It is possible that symptom recognition and self-care management activities would have been present and therefore measured by the SCHFI, if this study had employed a 30-day post hospitalization evaluation as in the Awoke et al., and Liou et al. studies.[14,15]

Gamification and its role in Heart Failure Education

Gamification has been utilized as a means to impact knowledge and self-care management in other chronic illnesses. Heinrich et al.[18] studied the effect of gamification in diabetic patients utilizing DIEP (Diabetes Interactive Education Programme) and found a significant effect on knowledge ($p < .01$) though only half of the patients utilized the self-care management component.[18] Study patients reported that the DIEP was strong in content, credibility, user friendliness, and noted that it provided another means of education other than written education.[18] Lehman et al.[9] studied AIDA (Action, Insulin and Diet Adjustment) gamification for diabetics, which has been utilized for 15 years as a simulation game for glucose and insulin control. They found that AIDA gamification had a significant impact on symptom recognition and self-care management in the diabetic population.[9] Greenwood, Gee, Fatkin, and Peeples[19] in a systematic review and meta analyses focusing on the use of technology in diabetes self-management, education and support, found that technology improved hemoglobin A1C levels in 18 of 25 articles reviewed. Incorporating technology that enabled self-management, fostered communication between the patient and their healthcare team, analyzed the individual health data with tailored education, and provided prompt feedback were recognized as key

interventions recommended by the United States National Standards for Diabetes Self-Management Education and Support.[19]

The literature suggests that gamification is a new approach in heart failure education and management as well. Dilles et al.[20] in a non-superiority study with hospitalized heart failure patients found that computer assisted heart failure education was as effective as written heart failure education. Dithmer et al.[21] utilized The Heart Game in a telerehabilitation program for recently discharged patients, predominantly with myocardial infarction. The game engaged patients and their support person to engage in healthy choices and connected them with other patients playing the game.[21] The patients and their support person reported feeling that the tasks of the game provided a means for them to return to health and enjoyed the social networking with others.[21] Senior adults (age 65 or older) also find benefit in digital game playing. Duplaa et al.[22] studied 590 Canadian non-hospitalized seniors who were self-described digital game players and found digital games had cognitive and socioemotional benefits.

Patients reported high levels of satisfaction with the Heart Failure Coach game. Patients rated the Heart Failure Coach consistently as helpful in heart failure maintenance, symptom recognition, likeability and usability. Similar findings of likability and usability were found in prior study by Radhakrishnan et al.[23] who measured the impact of a digital heart failure game prototype on self-care knowledge and self-care efficacy. Likability and usability were both 100% ; self-care measures were not reported.[23] More patients in this study reported that they preferred additional education to be presented by the Heart Failure Coach (45%) over traditional education (15%). Similar findings were noted with Radhakrishnan et al.[23], who found patient with lower education levels preferred games to any other educational method ($p < .02$). These findings support that the Heart Failure Coach was easy to use, reinforced education, provided an

alternative method of education, allowed for problem solving and encouraged the role of a support person.

Limitations

There were limitations to this study. First, the sample in this study was a small, non-randomized convenience sample recruited in a short time period. During enrollment, many of the patients on the units were pre or post heart transplant patients that further limited eligible patients. Another limitation was the prevalence of psychoneurological factors that excluded 33 of the 107 patients (30.8%). A final limitation to the study design was the lack of symptom expression in this sample. According the SCHFI v. 6 .2 guidelines, the patient must have symptoms of shortness of breath or ankle swelling to score the self-care management subscale. As only three of the 17 patients had one of these symptoms, symptom recognition and self-care management could not be accurately assessed. A new SCHFI (v. 7.2) has been developed, which allows for measurement of symptom recognition and self-care management specifically.[24] Psychometrics for the SCHFI v. 7.2 were not available during the implementation of this study, but have subsequently released.[25]

Practice Implications

The Heart Failure coach was an effective means of reinforcing self-care in heart failure education. Placing patients in virtual heart failure scenarios prior to discharge helped to identify opportunities for clarification or further education opportunities before leaving the acute care setting. The results of this study indicated that an innovative approach, such as gamification, in addition to traditional heart failure education may impact future heart failure self-care. More study is needed given the very limited report of gamification in heart failure patients in the literature and given that decades of traditional heart failure education have shown to increase

knowledge. Playing with a support person was also a unique feature of the Heart Failure Coach. The literature supports the role of the support person in fostering self-care maintenance, in helping to assess symptoms, and act on those symptoms (management). Yunus and Sharoni[26] studied 113 outpatient cardiology patients and the role of social support in self-care management. Their study found a positive correlation between social support and self-care management, and suggests that social support be used as a predictor in patients with heart failure.[26] Finally, patients listed a greater number of educational items they desired to be addressed by the Heart Failure Coach versus traditional education methods. This may have impact in the role of the heart failure educator and how that education is provided.

Future Recommendations

In the future, this study should be repeated with larger, randomized sample comparing traditional heart failure education to heart failure education utilizing gamification. Ideally this would occur for a longer duration lending to multiple follow-up SCHFI scoring points (e.g. seven days, 30 days and 90 days). Continuing to utilize Riegel et al.[4], Situation Specific Theory of Heart Failure Self-care, with the SCHFI v. 7.2[24] should be employed to assess self-care maintenance, symptom recognition and self-care management. With a larger sample size, correlations between demographic variables such as severity of illness or education level should be analyzed. Ultimately, the impact of gamification on resistant outcomes such as readmission is worthy of study.

Conclusion

This was a quasi-experimental study that examined the effect of gamification on heart failure self-care in hospitalized heart failure patients after their completion of traditional heart failure education. This study was relatively easy to employ and well received by patients and

their support person. The SCHFI v 6.2 was utilized to assess the effect in heart failure self-care, with significant improvement noted self-care maintenance and self-care confidence ($p < .002$ and $p < .001$ respectively). Due to only three out of 17 patients experiencing symptoms of shortness of breath or ankle swelling in the week post-discharge, self-care management and symptom recognition could not be analyzed utilizing the scoring guidelines.

Heart failure gamification used in this study did improve heart failure self-care maintenance and confidence. Gamification is an innovative method to improve patient heart failure knowledge; and may serve as a preferred method of heart failure education particularly in patients with lower education level. The Heart Failure Coach was well liked and easily used across all ages. It provided a simulated environment for education that could be done independently or with a support person. Further exploration of the use of heart failure gamification in the role of heart failure symptom recognition and management should be explored.

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WHAT'S NEW

- This quasi-experimental design was one of few studies that looked specifically at heart failure gamification and its effect on heart failure self-care.
- Mean pre-gamification SCHFI and post-gamification SCHFI scores improved statistically: Self-care maintenance $p < .002$ and self-care confidence $p < .001$.
- Heart failure gamification had comparable SCHFI scores to nurse-led heart failure gamification.

Table 1. Heart Failure Coach Demographics

	n	%	Range	Mean (SD)
Gender	20			
Female	7	35		
Male	13	65		
Age			27 – 91	61.15 (15.58)
Race				
African American	3	15		
White	15	75		
Other	2	10		
Education				
Less than 12 years	2	10		
12 years complete	3	15		
College Complete	6	30		
Post Undergraduate Studies	9	45		
NYHA Class				
Class I	1	5		
Class II	0	--		
Class III	9	45		
Class IV	10	50		
New Diagnosis of Heart Failure				
Not new Diagnosis	15	75		
New Diagnosis	5	25		
Diabetes				
No History	11	55		
Positive History	9	45		
Hypertension				
No history	5	25		
Positive History	15	75		
Hyperlipidemia				
No history	6	30		
Positive History	14	70		
Played with support person				
No support person	14	70		
Played with spouse (minimal)	6	30		

Table 2. Patient Satisfaction Questionnaire Likert Scale Items

Item	n	%	Range	Median	IQR
Weigh Daily			1-5	5	0
Agree	2	10			
Strongly Agree	18	90			
Medications			1-5	5	0
Agree	1	5			
Strongly Agree	19	95			
Salt Intak			1-5	5	0
Neutral	1	5			
Agree	5	25			
Strongly Agree	14	70			
Fluid Intake			1-5	5	0
Neutral	2	10			
Agree	6	30			
Strongly Agree	12	60			
Symptoms			1-5	5	0
Neutral	1	5			
Agree	4	20			
Strongly Agree	15	75			
Unsure Call			1-5	5	0
Disagree	1	5			
Neutral	1	5			
Agree	4	20			
Strongly Agree	14	70			
Worsen Call			1-5	5	0
Agree	2	10			
Strongly Agree	18	90			
Easibility			1-5	5	0
Agree	3	15			
Strongly Agree	17	85			
Likability			1-5	5	0
Neutral	1	5			
Agree	2	10			
Strongly Agree	17	85			

Table 3. Patient Satisfaction Questionnaire – Education Items

Item	n	%
Heart Failure Coach Education		
Self-Care Maintenance	5	25
Symptom Recognition	2	10
Self-Care Management	2	10
No Item Identified	11	55
Traditional Heart Failure Education		
Self-Care Maintenance	1	5
Symptom Recognition	2	10
Self-Care Management	-	--
No Item Identified	17	85
Additional TIGR videos		
Not Viewed	16	80
Viewed	4	20

Table 4. SCHFI Pre and Post Heart Failure Coach Game – Paired Samples T-Test

Item	Pre-Game Mean (n=20)	SD	Post-Game Mean (n=17)	SD	*t*	95% CI	p value
SCHFI Maintenance	57.28	± 18.20	73.00	± 9.07	-3.769	-24.58 - -6.88	0.002
SCHFI Confidence	56.54	± 20.81	82.03	± 10.67	-4.570	-25.49 - -13.67	<0.001

Note. SCHFI = Self-Care in Heart Failure Index. From "Self-Care in Heart Failure Index Version 6.2," Riegel, B, Lee, C, Dickson, V, & Carlson, B. An Update on the Self-Care of Heart Failure Index. *J Cardiovas Nurs.* (2009); 24(6): 485-497.

Figure 1: The situation-specific theory of heart failure self-care, revised and updated[26]

Riegel, B, Vaughan Dickson, V, & Faulkner, KM. The situation-specific theory of heart failure self-care. *Journal of Cardiovascular Nursing*. (2019); 31(3), 226-235. doi:10.1097/JCN.0000000000000244