IVR Technology Use by Patients with Health Failure: Utilization Patterns and Compliance

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3 Abstract

Heart failure (HF) is the leading cause of cardiovascular morbidity and health care utilization in Canada. Much of the cost for HF is related to hospitalization, strategies to decrease cost need to focus on avoiding unnecessary readmissions to the hospital. Interactive voice response (IVR) is an automated telephony system that leverages existing telephone lines to monitor patients post-discharge from a hospital, for early intervention. Limited evidence exists on the pattern of use and success of IVR technology among patients with heart failure and how IVR impacts their compliance. This study explores the pattern of IVR use by HF patients in the IVR program at the University of Ottawa Heart Institute (UOHI), describes their characteristics and IVR patterns of use in relation to occurrence of symptoms, compliance behavior (e.g., weighing themselves, medication compliance) and service utilization (i.e., hospital readmission). The system is based on an algorithm that triggers automated telephone calls to patients at a predetermined time for 3 months after discharge. A total of 902 HF patients were considered with a mean age of 70 years (59.4% male). Over the 12 weeks, results showed an overall increase in medication adherence and a decrease in symptom occurrence, weight gain and readmission rates. The highest compliance rate in this study was found in medication adherence and the lowest was found in the variable associated with exercise. The risk of readmission for patients who completed the IVR call, answered all the questions and listened to the educational prompts was lower than the patients who were called back by nurses. These results suggest that IVR calls do have a positive impact on HF patients. The increased use of IVR in remote patient monitoring will allow for a cheaper and more accessible form of at home monitoring. Leveraging IVR technology to support other conditions, especially during a pandemic, may be beneficial for patients to avoid unnecessary visits to the hospital and complications due to delay in seeking care.

4 Introduction

4.1 Background

Heart failure (HF) is a clinical condition that is associated with a high mortality rate and its occurrence is increasing in Canada (1). Among the reasons for the increase in HF prevalence is the progressive ageing of the general population, as well as the progressive increase in life expectancy of acute cardiac patients, which in turn lead to an increase of HF occurrence in people surviving a heart attack (1). Depending on the age of the patient and the stage of HF, around 10% to 50% of patients are readmitted in the 3 to 6 months after initial hospitalization (2). Frequent hospital readmissions makeup a significant portion of HF management cost. In the US alone, the cost of HF management is around $20 billion and is projected to reach $70 billion by 2030 (2). Hospital admissions for which HF is the primary diagnosis cost Canada $482 million in 2013, and costs are projected to increase to $720 million by 2030 (3).

Since much of the cost for HF is related to hospitalization, strategies to decrease cost need to focus on avoiding unnecessary readmissions to the hospital. However, chronically ill patients needing support for self-management are often those that are most likely to miss their appointments (4). While follow-ups via telephones may improve disease management (5), studies have shown that clinician-delivered telephone care result in limited cost savings (6,7). Hence automated approaches/technologies for monitoring, may fill the gap between what patients need and what clinicians can deliver in a sustainable and efficient way.

Research has shown that regular monitoring via information and communication technologies (ICTs) can support early detection of deterioration in HF patients, which in turn reduces rehospitalization rates and the use of more resources (8). In the past, remote monitoring, in the form of structured telephone support and telemonitoring, have been used to provide effective

out-of-hospital support to HF patients (9). One method used in monitoring patients after discharge is interactive voice response (IVR). IVR is an automated telephony system that leverages existing mobile and telephone lines for monitoring the condition of patients (10).

The IVR system is programmed to call patients at a pre-set time to ask questions from a predetermined list or give patients health related information. Patients answer questions by using voice recognition or by using their phones' keypad. The patient's responses are sent back and stored in a secure database. Depending on the patients answer to a question, their response is flagged as no action is needed, call was not answered, or notify a nurse to intervene, by which a nurse would call back the patient to provide assistance (11).

Most up-to-date telehealth studies have only focused on home telemonitoring (HTM) (12,13). HTM includes the use of special at home devices that automatically transmit patient health care data to health care professionals (14). Even with the positive effects on disease self-management, HTM can be inaccessible for some. Such technologies require good broadband connectivity, which is hard to achieve for smaller healthcare institutions and rural hospitals (15). Furthermore, elderly patients often face difficulties in using modern gadgets, such as smart phones (15). Whereas, IVR monitoring is a simple, yet effective telehealth application that improves access to health care by continuing care beyond the hospital setting, with programs that are easily accessible to patients around the clock (16).

There is limited and conflicting evidence concerning IVRs clinical value as stated in a Cochrane Review on automated telephone communication systems (17). Concerns remain about patients not being able to use IVR or that they may see it as an obstacle that limits their contact with their physicians (18). Only a few studies have examined IVR use in clinical trials, and limited

evidence exists in relation to the pattern of use and success of IVR technology among patients with HF.

4.2 Research question/objective

This research aims to address the gap by exploring the pattern of IVR use by patients with HF and their compliance behavior when using this technology. Specifically, it focuses on HF patients enrolled in the IVR program at the University of Ottawa Heart Institute, describes their characteristics and patterns of use, and investigates patient symptoms, differential compliance behavior (i.e., medication compliance, diet restriction, weight gain) and service utilization (i.e., hospital readmission) based on IVR use. Hence, this research addresses the following questions:

1. What is the relationship between IVR system use and HF patient symptom occurrence, medication adherence, weight, and lifestyle compliance? Is there a variation over time in relation to sex, hospital site, and age?
2. What is the relationship between symptom occurrence, medication adherence, weight and lifestyle compliance and service utilization (readmission)? Is there a variation over time in relation to sex, hospital site, and age?
3. What is the relationship between IVR system use and service utilization (readmission)? Is there a variation over time in relation to sex, hospital site, and age?

5 Literature Review

5.1 Heart Failure Condition

Heart failure (HF) is a leading and growing cause of cardiovascular morbidity, mortality, and health care use in Canada (19). It currently affects 600,000 Canadians and is the primary cause of hospitalization, which results in a yearly cost of $2.8 billion dollars in direct health care expenses (20). HF is a condition that develops after the heart becomes damaged or weakened. As more people survive heart attacks and live longer with damaged hearts, they become more susceptible to heart failure (20).

Heart failure is a chronic long-term condition that deteriorates with time and does not have a cure. Medications and lifestyle behaviors are part of every patient's treatment and management plan (21). Chances of HF survival heavily depend on a patient's management of their condition. Yet patients with HF are often frail, which may limit their ability to manage their symptoms and access health care services (22). Poor regimen compliance often worsens HF and limit the rate of recovery (23). While the use of intensive care can improve short-term HF outcomes, the intensity of these interventions make it difficult to sustain, and are often unavailable to patients because of their cost (24,25)

The transition from hospital discharge to at-home recovery is a high-risk period for HF patients (26). Studies have shown that this crucial time is when the most complications and adverse drug effects occur (11). Over the first six months post-discharge, there is a sharp decline in adherence to cardiac medications, which results in poor health outcomes and increased adverse events. Adverse drug events significantly prolong hospital stays, increase economic burden and nearly double the risk of death (11).

This transition period is associated with a lack of continuity among providers and in many cases, poor communication between hospital and primary physicians. Data from earlier studies show that 47% of patients 70 years or older hospitalized with HF were readmitted one or more times within 90 days of discharge, and that several potentially modifiable factors often contributed to readmission (27). A study that looked into adverse events among patients post-discharge found that 23% of patients discharged from a hospital had an adverse event after discharge, and more than half were adverse drug events that could have been prevented (28). Forster et al. (2004), concluded that system modifications are needed to improve patient safety during the vital transition period (28).

The Heart Failure Society of America guidelines (29) recommends that all patients with HF receive pharmacological therapy (diuretics, angiotensin-converting enzyme (ACE) inhibitors, and Beta-blockers) to improve symptoms and survival rates. Non-pharmacological life-style changes such as fluid- and sodium-restriction, daily weighing, adjustment of activity, smoking cessation and limitation of the amount of alcohol are also recommended (30). According to guidelines, patients with HF are advised to weigh themselves daily as weight gain is an important indicator of worsening HF (30). If an increase of 3 pounds in one day or 5 pounds in one week is observed, patients should contact medical or nursing personnel (29).

Non-compliance with medication and diet contributes to worsening HF symptoms, in many cases leading to hospitalization. The highest rates of non-compliance are found in diet and fluid restriction, daily weighing, and activity (31). The World Health Organization (WHO) defines compliance as the extent to which a patients behaviour corresponds with the agreed recommendations from a health care provider (32). In this study, compliance is defined as ‘the

extent to which a person's behaviour (in terms of taking medication, following diet, or executing lifestyle changes) coincides with the clinical recommendation.

Studies recognise the problem of non-compliance in HF; however, most publications focus mainly on compliance with medication and overlook other important lifestyle changes. It has been shown that knowledge alone does not improve medication compliance in elderly HF patients. Additionally, there is limited insight on which interventions are tested and are successful in improving patient compliance. Currently, there are a limited number of studies on interventions to improve compliance in a HF population (33).

The aim of patient monitoring is to provide early detection of any signs of deterioration (34). Telehealth technology, including mobile health and remote patient monitoring technologies, provide a substitute for in-person interactions, resulting in more cost-effective solutions for patient monitoring techniques (35). A systematic review on home telemonitoring interventions on HF patients concluded that remote monitoring does improve survival rates and reduce the risk of HF-related hospitalizations in patients with HF (8). The primary benefits of remote monitoring for patients include; better access to healthcare, improved quality of care, improved support, education and feedback (36). There are also benefits of remote patient monitoring for clinicians, such as; ease of access to patient data, the ability to deliver higher-quality care to more patients with lower costs and higher efficiency (36).

5.2 Role of Health Information Technology

Health information technology (HIT) can improve the access and efficiency of patient care (37). The use of HIT may be particularly helpful in the care of older patients, as they often have multiple acute and chronic conditions that require ongoing management by many different professionals

(38,39). By having patient clinical data remotely collected on a regular basis, HIT can allow for early intervention to reduce mortality rates and further deterioration of a patient's condition (8).

Home telemonitoring (HT) is an example of HIT and is a form of remote patient monitoring that has potential to improve the care and management of patients with chronic HF (8,40). HT involves the use of electronic devices, such as monitoring devices, wearable technologies, and sensors. Such telecommunication technologies are used to transfer disease-related data from a patient's home to a health care professional to provide care and clinical feedback (8).

Another example of HIT is interactive voice response (IVR). IVR uses speech recognition technology where patients receive automated phone calls at scheduled intervals and are asked a pre-set series of questions. Patient responses are held in a secure database, where they are marked as no action needed, requiring a call of reassessment or action by a nurse is needed (41). The system offers accessibility around the clock without geographic restriction (16,41).

There are several reasons that highlight the advantage of using IVR in health care. The most commonly used technology in the world, is the telephone (41). In Canada, nearly every household (99.1%) owns and uses a telephone compared to having a computer (79.4%), the second most prevalent communication device. Another advantage of IVR is that the technology is continuously available and is less costly than live operators (41). However, despite easy access to telephone services and growing familiarity with IVR in other settings such as in banking services, health care providers and consumers are largely unaware of the potential of these programs for the delivery of health care (16). Thus, IVR remains under researched and underdeveloped.

5.3 IVR and Heart Failure

There are only a few studies that have assessed the feasibility and reliability of IVR systems in the diagnosis and management of chronic diseases. IVR has been implemented in the treatment

of patients with chronic cardiac problems. Friedman et al. (1996), investigated the impact of IVR usage on monitoring and counseling patients with hypertension. Patient use of IVR resulted in higher rates of adherence to antihypertensive medication, compared to the control group that did not use IVR (42). Sherrard et al. (2015), evaluated whether the use of an IVR follow-up system improve compliance with acute coronary syndrome best practice guidelines. Patients in the IVR group showed a 60% improvement in medication compliance and decrease in unplanned medical visits compared to patients in the usual follow-up care group (43). The researchers concluded that IVR can be effective in improving adherence to medications (43).

Patel and Babbs (1992), investigated the impact of an automated, telephonic system in monitoring the progress of at home patient recovery (44). Results showed that patients with cardiac disease readily used the system without problems or complaints. In one patient weight increase was detected, which in turn prompted the patient's cardiologist to adjust his medication (44). The automated telephone follow-up made at home recovery safer and contributed to reducing health-care costs. Some studies have also researched the impact of IVR-supported disease management in low income countries (45), showing that the technology can be utilized even in limited resources. In fact, IVR serves a unique role in such circumstances, especially for patients with low literacy or no access to the internet (46).

With that said, acceptability is an important issue for IVR use, especially in relation to the attitude of patients and their acceptance of IVR. Katz et al. (1997), revealed that older participants had more negative attitudes and more unsatisfactory experiences with IVR systems compared to younger people (47). The factors behind why older people are finding trouble and difficulties interacting with automated systems are still not understood, mainly because of the lack of research in the area. There are many factors such as age, gender, and comorbidities, that may influence how

a patient uses the IVR program and to this date, no prior study has investigated the differential use and benefit of IVR among different groups of patients.

This research addresses this area and investigates IVR use among patients with HF. Specifically, it presents a general overview of IVR use among HF patients at the University of Ottawa Heart Institute and examines the patterns of behavior compliance and service utilization among different groups of patients. Behavior compliance is defined as adherence to prescribed medication and therapy compliance. Therapy compliance is described as tracking one's weight and following diet/fluid restrictions. Whereas service utilization is defined as hospital readmission

This study takes on an inductive reasoning approach, by drawing conclusions from the data analyzed. Inductive reasoning forms broad generalizations from what's known and observed in the data. It is the opposite of deductive reasoning. deductive reasoning starts out with a hypothesis, and examines the possibilities to reach a specific, logical conclusion.

5.4 Research propositions

Figure 1 illustrates the study's propositions. The study will first investigate the relationship between system use and HF patient symptom occurrence, medication adherence, weight, and lifestyle compliance. Then the relationship between symptom occurrence, medication adherence, weight and lifestyle compliance will be examined against service utilization (readmission). Finally, the relationship between system use and service utilization will be explored. Patient sex, age and hospital site will be taken into consideration at each point of the analysis, to observe if there is a variation over time.

With this approach, the study will be able to investigate the relationship between IVR system use and HF patient symptom occurrence, medication, weight, and lifestyle compliance. The association between symptom occurrence, behaviour compliance and service utilization (readmission) will also be explored. Lastly, the relationship between IVR system use and service utilization (readmission) will be examined. At each point of the investigation, the variables sex, hospital site, and age will be controlled for to inspect if there is a variation over time.

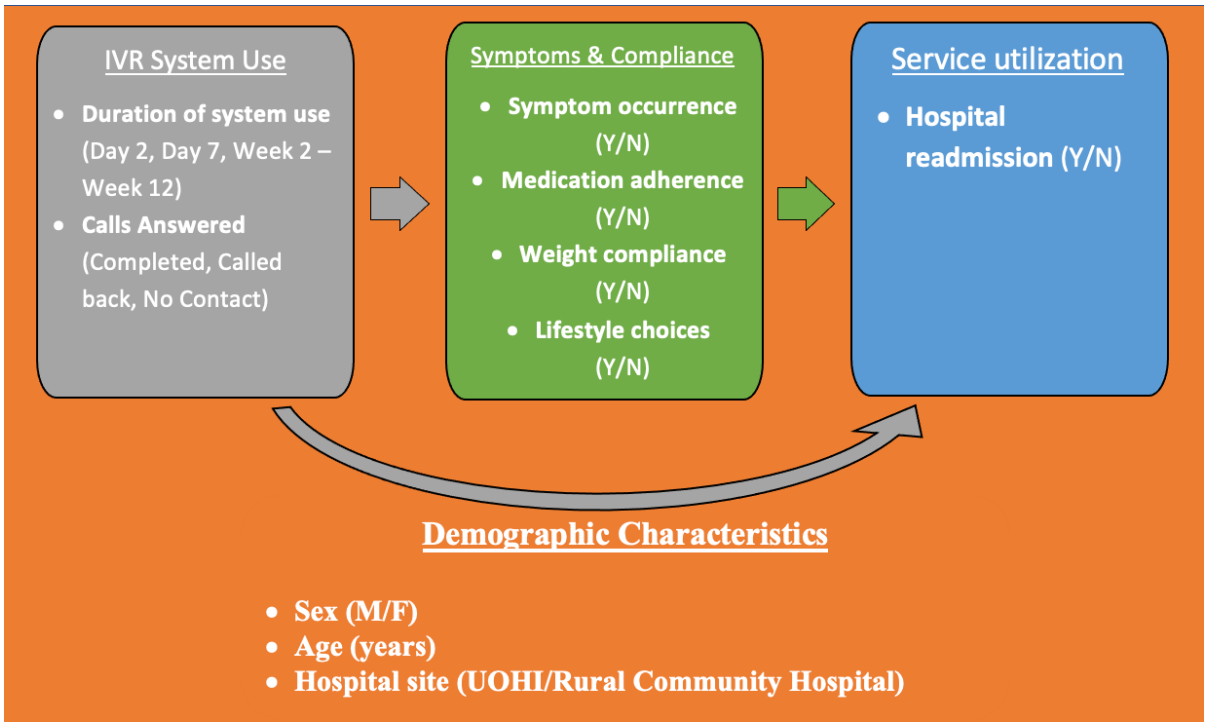


Figure 1. Research project propositions.

6 Methodology

6.1 Study Design and setting –

In evaluating the utilization patterns and compliance behavior of heart failure (HF) patients using interactive voice response (IVR), an exploratory approach is used. Exploratory research is typically conducted on newly researched topics. It is used when the aims of the research are: 1) to determine the magnitude or extent of a particular phenomenon (IVR) 2) gather some initial ideas about that phenomenon, or 3) to test how feasible it would be to undertake a more extensive study regarding the phenomenon.

Evaluating the use of IVR on HF patients at UOHI is a newly researched topic. The goal of this study is to explore the pattern of IVR use by patients with HF and their compliance behavior when using this technology. In turn, this will be providing information in scoping out what patient characteristics IVR appeals best to, increase IVR usage as a tool in remote monitoring and be able to maximize the efficacy of the technology.

To achieve the objectives of this research, a quantitative approach will be used to analyze the data collected by the UOHI. This type of design focuses on the statistical relationship between the major variables without controlling extraneous variables. Since nothing is being manipulated or controlled, the results are more likely to reflect relationships that exist in the real world.

6.2 Study Participants

The sample used in the study consist of HF patients who were admitted to the University of Ottawa Heart Institute (UOHI) or other rural community hospitals and were enrolled into the UOHI well-established IVR program. The rural community hospitals involved are Cornwall Community Hospital, Pembroke Regional Hospital, Renfrew Victoria Hospital, and Winchester District Memorial Hospital. Patients included in the study were over the age of 18 years old with a

diagnosis of heart failure who were enrolled into the IVR program at the UOHI during the years 2010-2019. Exclusion criteria include patients 1) without access to a landline telephone or cellular service; 2) with a disability which prevents them from using a phone or 3) whose first language is not English or French. By looking into 10 years' worth of patient data, we will have a large enough sample size which will be more representative of the target population and allow for greater validity and more generalizable findings.

6.3 Materials and Measurements

The IVR system used by UOHI is made by the Canadian company, TelAsk (48). This IVR system was selected on the basis of technical quality and established experience, as it has been previously used in multiple IVR studies conducted at UOHI (43). The purpose behind the IVR algorithm is to detect any health issues with enough time for intervention, track medication compliance, provide patients with knowledge on the medication they are taking upon their request and to enable long term patient follow-up.

The IVR system asks close ended yes/no questions addressing medication compliance, asking about weight and diet monitoring, reporting any adverse events, providing information on medications, and offering general safety and health related tips. Data collection is done using the IVR system, which works using a specific algorithm protocol, resulting in greater consistency of data collection by standardizing questions and reducing misinterpretation of responses.

Patients receive automated telephone calls at a predetermined time for three months, with calls made at day 2, day 7, weeks 2, 4, 6, 8, 10 and 12 after discharge. Each call lasts about five to eight minutes. The system attempts to call the patient during three call periods between 9–11 a.m., 1–5 p.m., and 7–8 p.m. A maximum of 3 attempts is made within a span of 2 days.

The IVR system has two components. The first is a clinical algorithm developed by Registered Nurses and heart failure physicians. This algorithm asks a specific set of questions related to heart failure in a specific order, in the same way a clinician would assess a patient. This ensures a consistent approach in the questions asked. Patients can respond by voice (which is converted to text) or by text messaging.

The second component of the system is data capture. The Registered Nurses who manage the IVR system review the responses and based on these answers, they call the patient for follow-up as required. Call-back protocols are also developed in a way to create standardized responses. If a patient's response is flagged by the system indicating they are no longer taking their medication(s), a nurse would call them back the next day and follow the call-back protocol. The IVR system is programmed to ask patient questions such as, but not limited to, worsening of swelling, difficulty breathing, weight gain and medication compliance. The system explains why such behaviors like weighing oneself or taking medication is important and would list the benefits and potential side effects if not done. The system is also able to offer extra information on the types of medication a patient is taking if asked to.

IVR calls at all time periods (Day 2 to week 12) require a response to questions regarding common HF symptoms such as worsening of ankle swelling, difficulty breathing at night, dizziness, and weight gain. All the calls after day 7 (week 2 to week 12), ask questions on medication compliance, fluid intake, the use of a saltshaker, reading food labels, following an activity program and if the patient was recently admitted to a hospital, as seen in Figure 2.

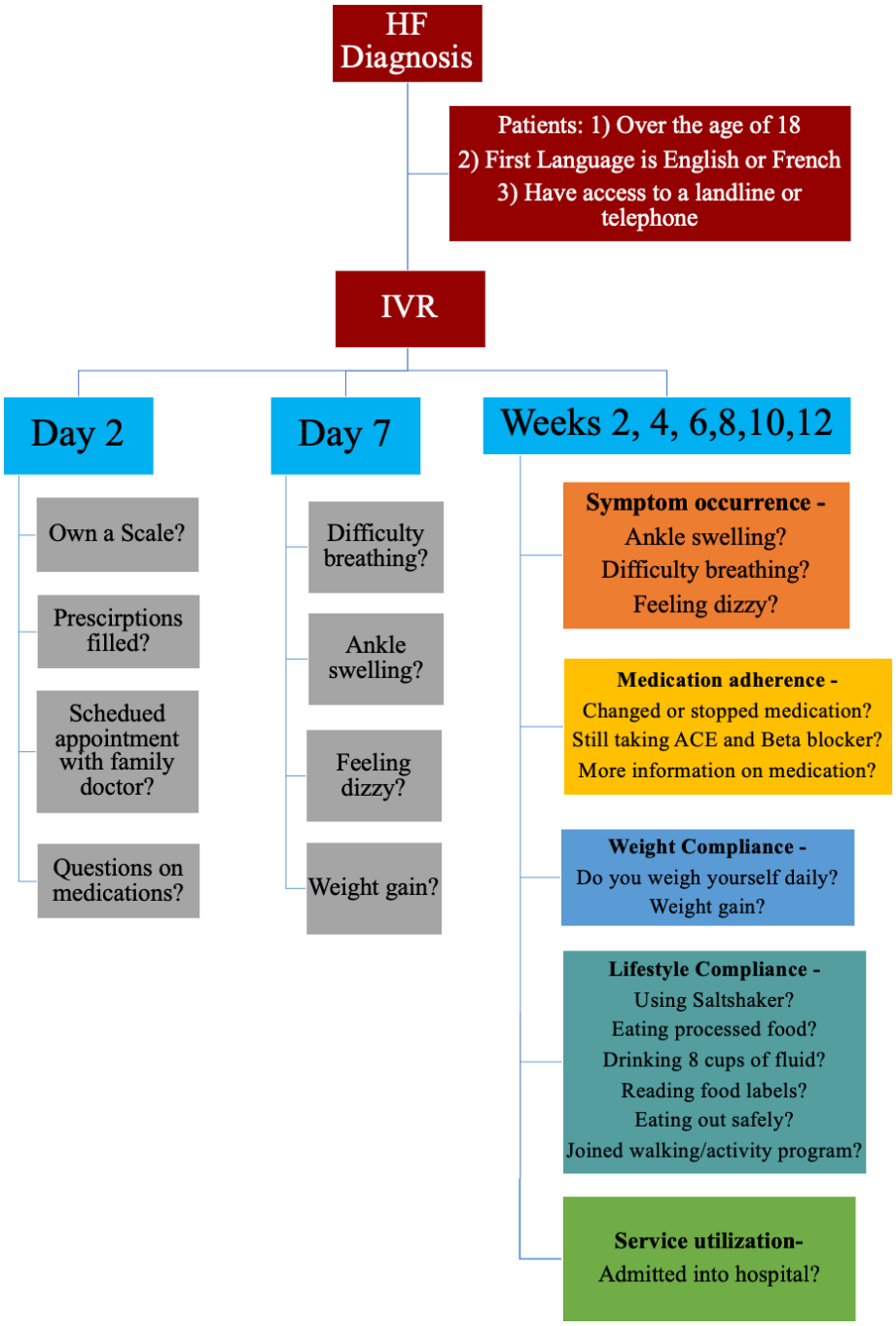


Figure 2. Overview of the IVR system and its underlining algorithm

6.4 Variables

Table 1. Description of variables used in the research project.

Variable	Description and Category
Sex	Male Female
Hospital Site	UOHI Rural Community Hospital
Age	Years
IVR system use	Call Completed: Patient completed the call, did not require a callback from a nurse Call Back: Patient completed the call, but required a callback from a nurse No Contact: Exhausted all attempts to reach patient. 3 attempts per day over 2 days.
Symptoms	Difficulty breathing (Y/N) * Worsening or new ankle swelling (Y/N) * Dizziness (Y/N) +
Medication	Changed or stopped taking heart medication on your own (Y/N) * Stopped taking Betablocker (Y/N) * Stopped taking ACEI/ARB (Y/N) *
Weight	Do you weigh yourself daily? (Y/N) º Has your weight increased more than 2 pounds in one day or more than 5 pounds in 1 week? (Y/N) *
Lifestyle	Using saltshaker (Y/N) + Eating processed food (Y/N) + Drinking more than 8 cups of fluid per day (Y/N) + Reading food labels (Y/N) º Eating out safely (Y/N) º Joined a walking/activity program (Y/N) º
Readmission	Been readmitted since last call (2 weeks) (Y/N) *
*Nurse is flagged to call patient back if patient answers question with 'Yes' +Educational prompts are given to patient if patient answers question with 'Yes' ºEducational prompts are given to patient if patient answers question with 'No'	

The variables in this study were chosen to assess the gap in the literature. Sex (M/F), hospital site (UOHI/Rural community hospital), and age (years) are the dependent variables and were used as a control at each point of the analysis. There are three system categories used to assess IVR system

use. ‘Call Completed’ is when a patient completes the IVR call, answering all the questions and not requiring a callback from a nurse. ‘Call Back’ is when a patient completes the call but requires a call back from the nurse for a follow up. Finally, ‘No Contact’ is when all attempts to reach a patient are exhausted (3 attempts per day over 2 days) and patient could not be reached.

The IVR system asks three questions to assess the occurrence of symptoms: difficulty breathing, ankle swelling and dizziness. Based on the literature if the occurrence of symptoms suddenly becomes worse or new symptoms develop, it may mean that existing heart failure is getting worse or that the patient is not responding to the treatment (49).

To assess medication compliance, the IVR system asks 3 questions; Stopped taking medication, Still taking Betablocker, Still taking ACEI/ARB. Betablockers and ACEI/ARB have been associated with lower adverse events in HF patients (50).

To monitor weight gain, the IVR system asks the patients if they weigh themselves daily before breakfast and whether their weight has increased with more than 2 pounds in one day or more than 5 pounds in 1 week. Sudden weight gain or loss can be a sign that the patient’s HF condition is progressing (51).

To monitor lifestyle choices, the IVR system asks the patients if they use a saltshaker, if they are eating processed food, drinking more than 8 cups of fluid per day, reading food labels, eating out safely and if they have joined a walking/activity program. Following recommendations about diet, exercise and other habits can help ease HF symptoms and slow disease progression (51).

To assess the rate of readmission the IVR system asks patients if they have been readmitted in the last 2 weeks (since the last call).

6.5 Statistical Analysis -

All analysis were carried out with SPSS statistical software version 22.0 (IBM Corp, Armonk, New York, USA). Descriptive statistics were computed for all variables considered in this research. Frequency and mean analyses were calculated for the three demographic variables considered, sex, hospital site and age. Bivariate analyses (Chi-square and ANOVA analysis) were conducted to assess the variation in symptoms, medication and weight and lifestyle compliance in relation to IVR use, sex, hospital site and age. Binary logistic regression analysis is used to predict the relationship between the independent variables (IVR use, patient compliance, service utilization) and the predicted dependent variables (sex, age, hospital site). Statistical significance is defined as $p < 0.05$.

6.6 Ethics Statement

Given the secondary nature of the data used in this research, an Ethics application was submitted to the University of Ottawa Research Ethics Board for approval explaining that no new data collection will be conducted, and that anonymized data will be shared from the UOHI for the purpose of this study.

7 Results -

7.1 Study population -

In total, 902 patients were enrolled in the UOHI IVR program, and their data was included in this study. As seen in Table 2, more than half of the participants were male (59.4%). The majority (67.4%) were UOHI patients and not from other regional community hospitals. Patients ages ranged from 24 to 102 years old with a median of 73 years.

Table 2. Demographic characteristics of the patients included in sample.

Variable	Patients (N=902)
	N (%)
Sex	
Male	536 (59.4)
Female	366 (40.6)
Hospital Site	
UOHI	608 (67.4)
Regional Community Hospitals	294 (32.6)
Age	
Median	73
[Min-Max]	[24 - 102]

7.2 Study outcome: Trends

The pattern of IVR system use among the sample population is seen in Figure 3. The highest rate of calls completed occurred in Day 7 (call 2), where 57.3% of the calls were completed. However, that was followed by a steep decline as only 27.3% of the calls were completed the following week i.e., at week 2 (call 3). Week 4 (call 4) shows a decrease in call backs and an increase in completed calls. Over the 12 weeks (8 calls) the number of no contact calls increased from 30.5% at week 2 (call 3) to 43.6% at week 12 (call 8), the number of call backs decreased from 35.8% at week 2 (call 3) to 20.6% at week 12 (call 8) and the number of completed calls stayed relatively equal at 33.7% at week 2 (call 3) and 35.8% at week 12 (call 8).

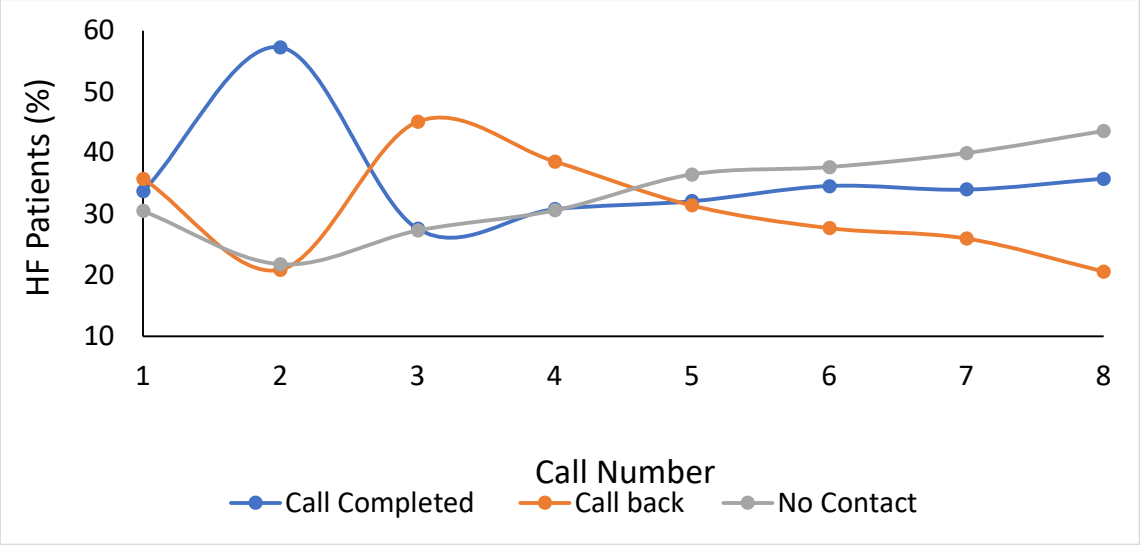


Figure 3. Pattern of IVR system pattern of use among HF Patients at Day 2 (call 1), Day 7 (call 2) and Weeks 2 – 12 (calls 3 -8).

Symptoms –

Figure 4 shows the pattern of patient's response to IVR questions on symptoms. At week 10, 11.1% of patients reported that difficulty breathing was waking them up at night, the percentage of patients decreased to a low of 9.3% by week 12.

When asked whether they have worsening or new ankle swelling, 11.4% said yes at week 6. That rate quickly declined, at week 8 only 8.7% of patients reported the occurrence of worsening or new ankle swelling. The number of patients continued to decrease to a low of 7.7% of patients at week 12.

The occurrence of dizziness was the final symptom question that the IVR system asked patients. At week 2, 17.5% of patients reported that the occurrence of dizziness was preventing them from doing their usual activities. That slowly declined to a low of 12.4% at week 10. However, by week 12, the percentage of patients increased back to 14.4%.

Medication –

IVR system asked three questions to assess medication compliance. The first being, whether patients have changed or stopped taking heart medication on their own. Over the course of 12 weeks the trend was steady with 4.7% of patients having stopped their medication at week 2 and a low of 1.6% of patients not taking medication at week 12. When asked about whether they are still taking their Betablockers, 15.5% of patients said that they have stopped taking their betablockers at week 2. At week 8, a low of 8.1% of patients stopped taking their betablockers, but that increased to 9.5% of patients at week 12.

The final question asked regarding medication compliance was whether patients are still taking their ACEI/ARB. The trend was relatively steady with a peak of 8.3% of patients saying no at week 8 and a low of 5.1% of patients saying no at week 12.

Weight –

Patients were asked two questions to assess weight compliance. The first being, whether they are weighing themselves daily before breakfast. At week 2, 12.5% of patients said no to weighing themselves, but by week 4 that decreased to 8.5% of patients saying no. The trend increases to 10.3% of patients at week 8 but then decreases to a low of 7.8% patients saying no at week 12.

The second question asked was whether the patients' weight increased by more than 2 pounds in one day or 5 pounds in 1 week. At week 2, it was reported that 8.8% of patients said that they did gain weight, and by week 6 the percentage of patients decreased to 7.3% saying yes to weight gain. By week 12, only 5.5% of patients had reported weight gain.

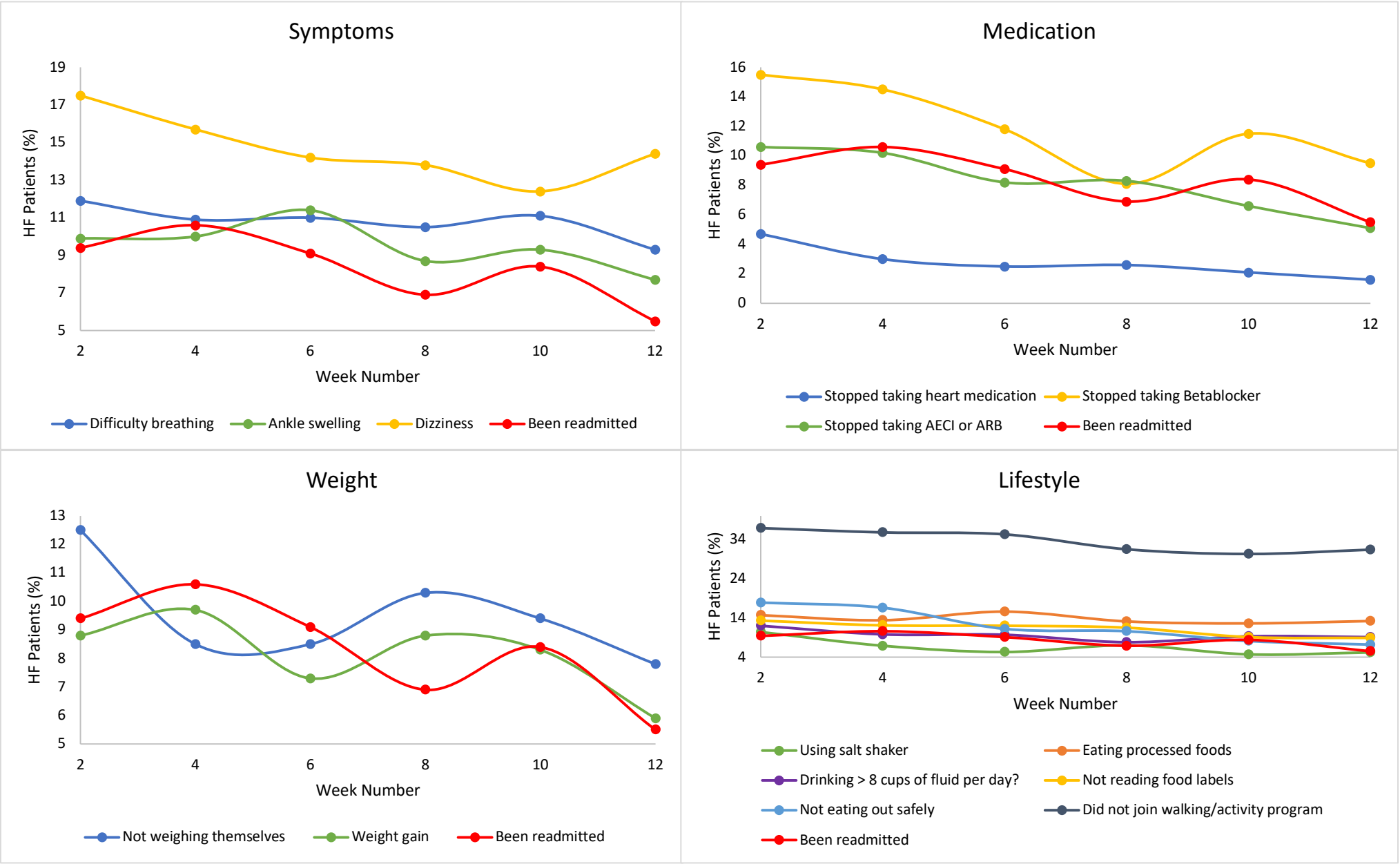
Lifestyle –

To assess whether everyday lifestyle choices were affecting HF patient's recovery, the IVR system asked a couple questions related to diet and activity. When patients were asked whether they are

using a saltshaker, 10.4% of patients said yes at week 2 and only 5.2% said yes at week 12. Patients were also asked whether they were eating processed food. There was a peak of 15.6% of patients saying yes at week 6, and that decreased to 13.2% of patients saying yes at week 12.

Another diet related question asked was whether patients were drinking more than 8 cups of fluid per day. At week 2, 12% of patients said yes to drinking more than 8 cups, but that decreased to a low of 7.8% at week 8. By week 12 the percentage of patients who said yes slightly increased to 9.1%. Patients were asked whether they were reading food labels, at week 2, 13.3% of patients said that they were not reading food labels. That decreased to a low of 8.9% at week 12. When asked if they were eating out safely, 17.9% of patients said no at week 2. However, that decreased to 7.2% at week 12. Finally, patients were asked if they had joined a walking/activity program. At week 2, 36.9% of patients reported that they had not joined an activity program. At week 10, 30.3% of patients said they had not joined an activity program.

Figure 4. Patterns of patient's response to IVR questions related to symptoms, medication, weight compliance and lifestyle plotted with pattern of readmission (red) over the 12-week call period



7.3 Study outcomes: Bivariate

IVR use

Table 3 presents the results of the bivariate analyses examining the significant relationships between patient demographic variables and the IVR call outcome measures (Completed vs. Called back, no contact) over the 12-week call period. The highest rate of calls completed occurred in Day 7, where 57.3% of the calls were completed. Of those who completed the call 59.5% were male, 68.2% were UOHI patients and the mean age was 70.7 years old. The highest rate for no contact occurred at week 12, where 43.6% of calls were not answered, 58% were male, 58.5% were UOHI patients and the mean age was 72.6. The highest rate of follow up calls was at Week 2 (nurses calling back 45.1% of the patients); 60% of those patients were male. There was no significant association between the different call time and patient demographic variables. When looking at the sample in total, at day 2, hospital site (i.e., UOHI or rural community hospital) was significantly associated with the total number of patients at 5% significance level, where the majority were UOHI patients. At Day 7 and week 2 to week 12, hospital site (UOHI) and mean age were significantly associated with the total number of patients and patients were found to be older in age. And at week 8, all of sex (male), hospital site (UOHI) and age (older) were significantly associated with total sample.

Table 3. Associations between IVR call (Completed vs. Call back, No contact) and demographic variables over the 12-week period.

IVR Call	Call Completed	Call back	No Contact	Total
	N (%)	N (%)	N (%)	N (%)
Day 2				
Total	246 (33.7)	262 (35.8)	223 (30.5)	731 (100)
Male	146 (59.3)	161 (61.5)	135 (60.5)	442 (60.5)
UOHI	186 (75.6)	202 (77.1)	119 (53.4)	**507 (69.4)**
Age (Mean ± SD)	69.9 ± 13.5	70.0 ± 13.6	71.7 ± 12.9	70.5 ± 13.6
Day 7				
Total	422 (57.3)	154 (20.9)	161 (21.8)	737 (100)

Male	251 (59.5)	87 (56.5)	90 (55.9)	428 (58.1)
UOHI	288 (68.2)	84 (54.5)	72 (44.7)	**444 (60.2)**
Age (Mean ± SD)	70.7 ± 13.1	72.5 ± 12.9	73.5 ± 13.8	**71.6 ± 13.2**
Week 2				
Total	248 (27.6)	405 (45.1)	254 (27.3)	898 (100)
Male	149 (60.1)	243 (60.0)	142 (58.0)	534 (59.5)
UOHI	193 (77.8)	284 (70.1)	129 (52.7)	**606 (67.5)**
Age (Mean ± SD)	68.6 ± 14.4	71.8 ± 12.6	71.7 ± 14.1	**70.9 ± 13.6**
Week 4				
Total	274 (30.8)	344 (38.6)	273 (30.6)	891 (100)
Male	169 (61.7)	198 (57.6)	162 (59.3)	529 (59.4)
UOHI	208 (75.9)	234 (68.0)	159 (58.2)	**601 (67.5)**
Age (Mean ± SD)	68.2 ± 13.2	72.3 ± 12.8	71.9 ± 14.8	**70.9 ± 13.6**
Week 6				
Total	285 (32.1)	279 (31.4)	324 (36.5)	888 (100)
Male	179 (62.8)	152 (54.5)	196 (60.5)	527 (59.3)
UOHI	214 (75.1)	192 (68.8)	192 (59.3)	**598 (67.3)**
Age (Mean ± SD)	68.4 ± 13.8	72.7 ± 12.2	72.1 ± 14.4	**70.9 ± 13.7**
Week 8				
Total	307 (34.6)	246 (27.7)	334 (37.7)	887 (100)
Male	199 (64.8)	127 (51.6)	201 (60.2)	**527 (59.4)**
UOHI	226 (73.6)	170 (69.1)	201 (60.2)	**597 (67.3)**
Age (Mean ± SD)	68.6 ± 13.1	72.6 ± 13.4	71.9 ± 14.1	**70.9 ± 13.7**
Week 10				
Total	301 (34.0)	230 (26.0)	345 (40.0)	885 (100)
Male	190 (63.1)	125 (54.3)	210 (59.3)	525 (59.3)
UOHI	230 (76.4)	156 (67.8)	210 (59.3)	**596 (67.3)**
Age (Mean ± SD)	69.3 ± 13.4	71.5 ± 12.3	71.9 ± 14.6	**70.9 ± 13.6**
Week 12				
Total	314 (35.8)	181 (20.6)	283 (43.6)	878 (100)
Male	199 (63.4)	100 (55.2)	222 (58.0)	521 (59.3)
UOHI	240 (76.4)	126 (69.6)	224 (58.5)	**590 (67.2)**
Age (Mean ± SD)	68.1 ± 13.4	72.5 ± 12.2	72.6 ± 14.2	**71.0 ± 13.6**
Bold values showed significant association ($p < 0.05$) between the IVR call and the respective independent variables (sex, site, and age)				

Symptoms -

Table 4 presents the results of the bivariate analysis examining the significant relationships between patient demographic variables and the IVR questions on symptoms (difficulty breathing, ankle swelling and dizziness) over the 12-week call period.

Difficulty breathing was found to be significantly associated with sex only at week 8. Where male patients (60.9%) were more likely to report symptoms of difficulty breathing compared to female

patients. A significant association was found between ankle swelling and the respective variables over the 12 weeks. At week 2, hospital site (UOHI - 74.7%) and mean age (70.1 ± 13.6) were significantly associated with patients experiencing ankle swelling. On average, patients that reported ankle swelling at week 2 were older, UOHI patients. At weeks 4, 8 and 10, all of sex, hospital site and age were significantly associated with patients experiencing ankle swelling. On average, patients that reported ankle swelling at weeks 4, 8 and 10, were older, male, UOHI patients. At week 6, sex (male - 61.2) and mean age (69.8 ± 13.2) were significantly associated with patients experiencing ankle swelling. On average, patients that reported ankle swelling at week 6 were older, male patients. At week 12, only mean age (69.2 ± 13.2) was significantly associated with patients experiencing ankle swelling, and on average, patients that reported ankle swelling at week 12 were older. The occurrence of dizziness was mainly significantly associated with hospital site. It was found that at weeks 4 and 8, hospital site was also significantly associated with patients experiencing dizziness and on average, patients that reported dizziness at weeks 4 and 8 were UOHI patients. At week 6, hospital site (UOHI - 74.5%) as well as sex (male – 61.6%) were significantly associated with patients experiencing dizziness. On average patients who experienced dizziness in week 6 were male, UOHI patients.

Table 4. Association between patients' characteristics and questions on symptoms, for patients who completed the IVR call, over a 12-week period.

	No Difficulty Breathing	No Ankle Swelling	No Dizziness
	N (%)	N (%)	N (%)
Week 2			
Total	572 (88.1)	581 (90.1)	531 (82.5)
Male	344 (60.1)	358 (61.6)	319 (60.1)
UOHI	420 (73.4)	**434 (74.7)**	394 (74.2)
Age (Mean ± SD)	70.6 ± 13.5	**70.1 ± 13.6**	70.2 ± 13.6
Week 4			
Total	547 (89.1)	551 (90.0)	512 (84.3)
Male	327 (59.8)	**338 (61.3)**	309 (60.4)

UOHI	399 (72.9)	**410 (74.4)**	**376 (73.4)**
Age (Mean ± SD)	70.5 ± 13.1	**69.8 ± 13.2**	70.4 ± 13.1
Week 6			
Total	504 (89.0)	497 (88.6)	479 (85.8)
Male	302 (59.9)	**304 (61.2)**	**295 (61.6)**
UOHI	367 (72.8)	365 (73.4)	**357 (74.5)**
Age (Mean ± SD)	70.6 ± 13.2	**69.8 ± 13.2**	70.3 ± 13.3
Week 8			
Total	496 (89.5)	504 (91.3)	475 (86.2)
Male	**302 (60.9)**	**312 (61.9)**	284 (59.8)
UOHI	360 (72.6)	**371 (73.6)**	**351 (73.9)**
Age (Mean ± SD)	70.6 ± 13.4	**69.7 ± 13.5**	70.0 ± 13.5
Week 10			
Total	472 (88.9)	477 (90.7)	458 (87.6)
Male	285 (60.4)	**290 (60.8)**	270 (59.0)
UOHI	347 (73.5)	**355 (74.4)**	337 (73.6)
Age (Mean ± SD)	70.4 ± 13.0	**69.9 ± 13.2**	70.2 ± 13.2
Week 12			
Total	450 (90.7)	456 (92.3)	421 (85.6)
Male	274 (60.9)	280 (61.4)	252 (59.9)
UOHI	334 (74.2)	340 (74.6)	318 (75.5)
Age (Mean ± SD)	69.6 ± 13.3	**69.2 ± 13.2**	69.8 ± 13.0
Bold values showed significant association ($p < 0.05$) between symptoms and the respective independent variables (sex, site and age)			

Medication -

Table 5 presents the results of the bivariate analyses examining the significant relationships between patient demographic variables and the IVR questions on medication compliance (Change in medication, taking betablockers and ACEI/ARB) over the 12-week call period. At week 2, hospital site (UOHI - 76.7%) and mean age (69.4 ± 12.9) were significantly associated with patients still taking Betablockers. Hospital site (UOHI – 79.4%) and mean age (67.7 ± 13.9) were also significantly associated with patients still taking ACEI/ARB at week 2. On average, patients that reported not taking Betablockers and ACEI/ARB were older, UOHI patients. At week 4, mean age (70.2 ± 13.1) was significantly associated with patients that were still taking their medication. Hospital site (UOHI – 77.1%) and mean age (67.2 ± 13.3) were also significantly associated with

patients still taking ACEI/ARB. On average, patients that reported not taking their medication and ACEI/ARB were older, UOHI patients. At week 6, hospital site (UOHI – 77.6%) and mean age (67.5 ± 13.5) were significantly associated with patients still taking ACEI/ARB. On average, patients that reported not taking ACEI/ARB were older, UOHI patients. At week 8, mean age (69.3 ± 12.8) was significantly associated with patients still taking Betablockers. On average, patients that reported not taking betablockers were older. At week 10, sex (male – 62.0%) was significantly associated with patients still taking Betablockers, and on average, patients not taking Betablockers were more likely to be male. Hospital site (UOHI – 77.4%) was significantly associated with patients still taking ACEI/ARB, on average patients not taking ACE/ARB were UOHI patients. At week 12, only mean age (67.5 ± 13.3) was significantly associated with patients still taking ACEI/ARB, and on average, patients that reported not taking ACEI/ARB were older.

In summary, on average patients that were more likely to stop taking their medication, betablockers and ACE/ARB were older, male, UOHI patients.

Table 5. Association between patients' characteristics and questions on medication compliance, for patients who completed the IVR call, with medications over a 12-week period.

	Did not stop Medication	**Still taking Betablockers**	**Still taking ACEI/ARB**
	N (%)	N (%)	N (%)
Week 2			
Total	611 (95.3)	420 (84.5)	355 (89.4)
Male	370 (60.6)	252 (60.0)	227 (63.9)
UOHI	451 (73.8)	**322 (76.7)**	**282 (79.4)**
Age (Mean ± SD)	70.5 ± 13.6	**69.4 ± 12.9**	**67.7 ± 13.9**
Week 4			
Total	585 (97.0)	408 (85.5)	336 (89.8)
Male	353 (60.3)	249 (61.0)	209 (62.2)
UOHI	424 (72.5)	301 (73.8)	**259 (77.1)**
Age (Mean ± SD)	**70.2 ± 13.1**	69.5 ± 12.6	**67.2 ± 13.3**
Week 6			
Total	540 (97.5)	367 (88.2)	312 (91.8)
Male	324 (60.0)	221 (60.2)	194 (62.2)
UOHI	394 (73.0)	272 (74.1)	**242 (77.6)**

Age (Mean ± SD)	70.3 ± 13.2	69.4 ± 13.2	**67.5 ± 13.5**
Week 8			
Total	534 (97.4)	386 (91.9)	311 (91.7)
Male	319 (59.7)	230 (59.6)	194 (62.4)
UOHI	385 (72.1)	281 (72.8)	233 (74.9)
Age (Mean ± SD)	70.2 ± 13.4	**69.3 ± 12.8**	68.3 ± 13.4
Week 10			
Total	510 (97.9)	353 (88.5)	296 (93.4)
Male	302 (59.2)	**219 (62.0)**	185 (62.5)
UOHI	376 (73.7)	260 (73.7)	**229 (77.4)**
Age (Mean ± SD)	70.1 ± 13.1	69.5 ± 12.5	68.2 ± 13.3
Week 12			
Total	483 (98.4)	341 (90.5)	281 (94.9)
Male	292 (60.5)	207 (60.7)	173 (61.6)
UOHI	360 (74.5)	255 (74.8)	218 (77.6)
Age (Mean ± SD)	69.7 ± 13.2	68.8 ± 12.7	**67.5 ± 13.3**
Bold values showed significant association ($p < 0.05$) between medication compliance and the respective independent variables (sex, site and age)			

Weight –

Table 6 presents the results of the bivariate analyses examining the significant relationships between patient demographic variables and the IVR questions on weight compliance (daily weighing and no weight gain) and readmission over the 12-week call period.

At week 2, hospital site (UOHI - 79.5%) and mean age (69.6 ± 13.5) were significantly associated with patients who weigh themselves daily. At week 4, hospital site (UOHI - 76.5%) and mean age (69.6 ± 13.2) were significantly associated with patients who weigh themselves daily. At week 8, hospital site (UOHI – 74.4%) and mean age (69.5 ± 12.9) were significantly associated with patients who weigh themselves daily. At week 10, hospital site (UOHI – 75.0%) and mean age (69.7 ± 12.9) were significantly associated with patients who weigh themselves daily. On average, patients that reported not weighing themselves every day at weeks 2, 4, 8 and 10 were older, UOHI patients. Hospital site was significantly associated with patients who weigh themselves daily at week 6 (UOHI – 75.4%) and week 12 (UOHI – 76.3%). On average the patients who do not weight

themselves daily were UOHI patients. As for patients who reported no weight gain over the past 2 weeks, sex was found significantly associated with sex at week 6 (male – 61.4%) and week 12 (male – 61.5%). On average, patients that reported weight gain at weeks 6 and 12 were male. At week 8, mean age (70.4 ± 13.2) was significantly associated with patients who reported no weight gain in the past 2 weeks, and on average, patients that reported weight gain at week 8 were younger.

Table 6. Association between patients' characteristics and questions on weight compliance and readmission, for patients who completed the IVR call, over a 12-week period.

	Daily Weighing	**No Weight Gain**	**No Readmission**
	N (%)	N (%)	N (%)
Week 2			
Total	517 (87.5)	536 (91.2)	523 (90.6)
Male	317 (61.3)	331 (61.8)	324 (62.0)
UOHI	**411 (79.5)**	408 (76.1)	401 (76.7)
Age (Mean ± SD)	**69.6 ± 13.5**	70.1 ± 13.5	69.7 ± 13.5
Week 4			
Total	520 (91.5)	511 (90.3)	496 (89.4)
Male	316 (60.8)	312 (61.1)	303 (61.1)
UOHI	**398 (76.5)**	380 (74.4)	368 (74.2)
Age (Mean ± SD)	**69.6 ± 13.2**	69.9 ± 13.1	69.7 ± 13.2
Week 6			
Total	476 (91.5)	482 (92.7)	466 (90.8)
Male	286 (60.1)	**296 (61.4)**	280 (60.1)
UOHI	**359 (75.4)**	358 (74.3)	346 (74.2)
Age (Mean ± SD)	69.9 ± 13.3	70.2 ± 13.2	69.6 ± 13.3
Week 8			
Total	469 (89.7)	477 (91.2)	480 (93.0)
Male	281 (59.9)	288 (60.4)	386 (59.6)
UOHI	**349 (74.4)**	348 (73.0)	351 (73.1)
Age (Mean ± SD)	**69.5 ± 13.2**	**70.4 ± 13.2**	70.1 ± 13.4
Week 10			
Total	460 (90.6)	463 (91.7)	460 (91.6)
Male	279 (60.7)	281 (60.7)	272 (59.1)
UOHI	**345 (75.0)**	339 (73.2)	339 (73.7)
Age (Mean ± SD)	**69.7 ± 12.9**	70.4 ± 12.9	70.0 ± 13.1

Week 12			
Total	435 (92.2)	444 (94.1)	444 (94.5)
Male	262 (60.2)	**273 (61.5)**	269 (60.6)
UOHI	**332 (76.3)**	331 (74.5)	331 (74.5)
Age (Mean ± SD)	69.3 ± 13.3	69.8 ± 13.2	69.5 ± 13.2
Bold values showed significant association ($p < 0.05$) between weight compliance, readmission, and the respective independent variables (sex, site, and age)			

Lifestyle -

Table 7 presents the results of the bivariate analyses examining the significant relationships between patient demographic variables and the IVR questions on patient lifestyle (not using saltshaker, not eating processed food, not drinking more than 8 cups of fluid, reading food labels, eating out safely and joining a walking/activity program) over the 12-week call period.

At week 2, sex (male – 62.8%) and mean age (69.8 ± 13.4) were significantly associated with patients who do not use a saltshaker. On average patients that reported using a saltshaker at week 2 were older, male patients. Mean age was significantly associated with patients who do not use a saltshaker at week 4 (69.8 ± 13.0) and week 12 (69.3 ± 13.2). On average patients that reported using a saltshaker at weeks 4 and 12 were older. At week 6, sex (male – 58.9%) was significantly associated with patients who do not use a saltshaker. On average patients that reported using a saltshaker at weeks 6 were male.

Mean age was significantly associated with patients who do not eat processed food at week 4 (69.6 ± 13.0), week 6 (69.4 ± 13.4) and week 12 (68.4 ± 13.5). On average patients that reported using eating processed food at weeks 4, 6 and 12 were older. At week 8, only sex (male – 60.9%) was significantly associated with patients who do not eat processed food. On average patients that reported using eating processed food at week 8 were male. Hospital site was significantly associated with patients who do not eat processed food at week 10 (UOHI – 73.5%) and week 12

(UOHI - 76.6%). On average patients that reported eating processed food at weeks 10 and 12 were UOHI patients.

Hospital site (UOHI – 76.0%) was also significantly associated with patients who do not drink more than 8 cups of fluid a day. On average patients that reported drinking more than 8 cups of fluid a day at week 8 were UOHI patients.

At week 2, sex (male - 60.1%), hospital site (UOHI - 78.3%) and mean age (69.7 ± 13.6) were significantly associated with patients who were reading food labels at week. On average, patients that reported not reading food labels at week 2 were older, male, UOHI patients. At week 4, hospital site (UOHI - 75.6%) and mean age (69.3 ± 13.3) were significantly associated with patients who were reading food labels. At week 6, hospital site (UOHI - 75.5%) and mean age (69.4 ± 13.3) were significantly associated with patients who were reading food labels. At week 10, hospital site (UOHI - 74.5%) and mean age (69.7 ± 13.1) were significantly associated with patients who were reading food labels. On average, patients that reported not reading food labels at weeks 4, 6 and 10 were older, UOHI patients.

At week 8, sex (male – 61.0%) and mean age (69.3 ± 13.5) were significantly associated with patients who were reading food labels. On average, patients that reported not reading food labels at week 8 were older, male patients.

Mean age was significantly associated with patients who eat out safely at week 2 (69.5 ± 14.0), week 8 (69.5 ± 13.3) and week 12 (69.5 ± 14.0). On average patients that reported not eating out safely at weeks 2, 8 and 12 were older. At week 10, hospital site (UOHI - 74.4%) was significantly associated with patients who eat out safely. On average patients that reported not eating out safely at week 10 were UOHI patients.

At weeks 2 to 12, all of sex, hospital site and mean age were significantly associated with patients who have joined a walking/activity program. On average, patients that reported not joining a walking/activity program at weeks 2 to 12 were older.

Table 7. Association between patients' characteristics and questions on lifestyle/diet, for patients who completed the IVR call, over a 12-week period.

	Not using saltshaker	Not eating processed food	No more than 8 cups of fluid	Reading food labels	Eating out safely	Join walking/activity program
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Week 2						
Total	545 (89.6)	516 (85.3)	529 (88.0)	516 (86.7)	481 (82.1)	369 (63.1)
Male	**342 (62.8)**	318 (61.6)	327 (61.8)	**310 (60.1)**	300 (62.4)	**244 (66.1)**
UOHI	418 (76.7)	395 (76.6)	407 (76.9)	**404 (78.3)**	369 (76.7)	**301 (81.6)**
Age (Mean ± SD)	**69.8 ± 13.4**	70.1 ± 13.6	69.9 ± 13.5	**69.7 ± 13.6**	**69.5 ± 14.0**	**68.4 ± 13.8**
Week 4						
Total	537 (93.1)	496 (86.6)	513 (90.2)	499 (87.9)	471 (83.4)	363 (64.2)
Male	322 (60.0)	296 (59.7)	305 (59.5)	304 (60.9)	290 (61.6)	**239 (65.8)**
UOHI	392 (73.0)	367 (74.0)	383 (74.7)	**377 (75.6)**	353 (74.9)	**288 (79.3)**
Age (Mean ± SD)	**69.8 ± 13.0**	**69.6 ± 13.3**	70.2 ± 12.9	**69.3 ± 13.3**	69.6 ± 13.1	**68.8 ± 13.3**
Week 6						
Total	501 (94.7)	445 (84.4)	475 (90.3)	462 (88.)	459 (88.8)	343 (64.7)
Male	**295 (58.9)**	272 (61.1)	286 (60.2)	282 (61.0)	282 (61.4)	**223 (66.8)**
UOHI	370 (73.9)	334 (75.1)	**361 (76.0)**	**349 (75.5)**	346 (75.4)	**273 (81.7)**
Age (Mean ± SD)	69.7 ± 13.2	**69.4 ± 13.4**	70.0 ± 13.4	**69.4 ± 13.3**	69.6 ± 13.3	**68.4 ± 13.5**
Week 8						
Total	491 (93.0)	458 (86.9)	485 (92.2)	464 (88.5)	465 (89.4)	356 (68.5)
Male	291 (59.3)	**279 (60.9)**	288 (59.4)	**283 (61.0)**	281 (60.4)	**231 (64.9)**
UOHI	358 (72.9)	340 (74.2)	355 (73.2)	342 (73.7)	340 (73.1)	**287 (80.6)**
Age (Mean ± SD)	69.8 ± 13.4	69.7 ± 13.7	70.1 ± 13.2	**69.3 ± 13.5**	**69.5 ± 13.3**	**68.8 ± 13.6**
Week 10						
Total	487 (95.3)	445 (87.4)	461 (90.7)	462 (90.9)	465 (91.9)	352 (69.7)
Male	294 (60.4)	267 (60.0)	280 (60.7)	281 (60.8)	276 (59.4)	**227 (64.5)**
UOHI	358 (73.5)	**335 (73.5)**	342 (74.2)	**344 (74.5)**	**346 (74.4)**	**283 (80.4)**
Age (Mean ± SD)	70.1 ± 13.0	70.0 ± 13.2	70.3 ± 13.0	**69.7 ± 13.1**	70.0 ± 13.0	**69.1 ± 13.4**
Week 12						
Total	452 (94.8)	414 (86.8)	432 (90.9)	432 (91.1)	437 (92.8)	323 (68.6)
Male	272 (60.2)	255 (61.6)	260 (60.2)	257 (59.5)	264 (60.4)	**205 (63.5)**
UOHI	339 (75.0)	**317 (76.6)**	328 (75.9)	325 (75.2)	327 (74.8)	**252 (78.0)**
Age (Mean ± SD)	**69.3 ± 13.2**	**68.4 ± 13.5**	69.6 ± 13.3	69.5 ± 13.1	**69.0 ± 13.3**	**68.6 ± 13.5**
Bold values showed significant association ($p < 0.05$) between patient lifestyle choices and the respective independent variables (sex, site and age)						

7.4 Study outcomes – multivariate

For the multivariate analyses, a binary logistic regression was run to show the association between the IVR call questions and the main independent variables (age, sex, and site) over the 12-week call period as well as, weeks 2 to 12 combined.

IVR use

Table 8 shows the association between completed IVR call and the independent variables (age, sex, and site). The positive coefficients indicate that as age increases, more patients are likely to complete the IVR call compared to younger patients, this is true for weeks 2 to 12.

It is seen that males are less likely to complete the IVR call, this is particularly true for week 8 (-0.460 (0.180)) as there is a significant association between IVR call and sex.

UOHI patients are less likely to complete the IVR calls compared to patients from rural and community hospitals. There is a significant association between hospital site and IVR call when weeks 2 to 12 are combined (-0.200 (0.080)).

Symptoms -

Table 9 shows the association between symptoms and the independent variables (including completed IVR call). Older patients are more likely to suffer from difficulty breathing, this is particularly true for week 6 (-0.039 (0.012)) and week 8 (-0.028 (0.011)) as there is a significant association between difficulty breathing and age.

As for ankle swelling, younger patients are more likely to suffer from ankle swelling than older patients. This is especially true for week 4 (0.029 (0.013)), week 8 (0.033 (0.015)) and week 12 (0.032 (0.017)), as well as weeks 2-12 combined (0.022 (0.006)). Males are more likely to be suffering from ankle swelling than females, as there is a significant association between ankle swelling and sex in week 8 (-0.855 (0.343)) and weeks 2 – 12 combined (-0.452 (0.127)).

Patients from UOHI are more likely to report ankle swelling than rural and community hospital patients. This is especially true for week 4 (-0.620 (0.296)) and weeks 2 to 12 combined (-0.293 (0.132)). Older patients are more likely to suffer from dizziness than younger patients. This is especially true for week 6 (-0.024 (0.010)). Males are more likely to be suffering from dizziness than females, as there is a significant association between ankle swelling and sex in week 6 (-0.569 (0.261)). Patients from UOHI are more likely to report signs of dizziness than rural and community hospital patients. This is especially true for week 6 (-0.576 (0.281)), week 8 (-0.523 (0.272) and weeks 2 to 12 combined (-0.320 (0.110)).

Table 8. Binary logistic regression showing the association between completed IVR call and the respective independent variables (age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Completed IVR Call							
Age	**0.016 (0.006)**	**0.022 (0.007)**	**0.020 (0.007)**	**0.020 (0.007)**	0.009 (0.007)	**0.024 (0.008)**	**0.018 (0.003)**
Sex	0.134 (0.171)	-0.031 (0.172)	-0.238 (0.177)	**-0.460 (0.180)**	-0.277 (0.183)	-0.231 (0.194)	**-0.166 (0.072)**
Hospital site	-0.311 (0.196)	-0.226 (0.191)	-0.144 (0.196)	-0.018 (0.198)	-0.336 (0.201)	-0.202 (0.215)	**-0.200 (0.080)**
Bold values showed significant association (p < 0.05) between the IVR call and the respective independent variables (sex, site and age)							

Table 9. Binary logistic regression showing the association between symptoms (Difficulty breathing, ankle swelling and dizziness) and the respective independent variables (IVR call, age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
No Difficulty Breathing							
Completed IVR Call	-0.124 (0.20e5)	0.15e2 (0.17e5)	0.065 (0.17e5)	-0.362 (0.20e5)	0.133 (0.23e5)	-0.168 (0.28e5)	0.13e2 (0.83e4)
Age	-0.007 (0.010)	-0.014 (0.011)	**-0.039 (0.012)**	**-0.028 (0.011)**	-0.022 (0.012)	-0.010 (0.014)	**-0.020 (0.005)**
Sex	0.081 (0.267)	-0.008 (0.286)	-0.316 (0.302)	-0.436 (0.310)	-0.277 (0.311)	-0.099 (0.350)	-0.185 (0.122)
Hospital site	0.022 (0.291)	-0.230 (0.301)	-0.409 (0.333)	-0.191 (0.347)	-0.081 (0.334)	0.094 (0.384)	-0.128 (0.133)
No Ankle Swelling							
Completed IVR Call	0.356 (0.23e5)	0.15e2 (0.17e5)	-0.038 (0.23e5)	0.15e2 (0.19e5)	0.327 (0.23e5)	0.453 (0.28e5)	0.14e2 (0.88e4)
Age	0.025 (0.012)	**0.029 (0.013)**	0.005 (0.013)	**0.033 (0.015)**	0.016 (0.015)	**0.032 (0.017)**	**0.022 (0.006)**
Sex	-0.284 (0.281)	-0.349 (0.294)	-0.527 (0.295)	**-0.855 (0.343)**	-0.401 (0.330)	-0.268 (0.375)	**-0.452 (0.127)**
Hospital site	-0.221 (0.295)	**-0.620 (0.296)**	-0.140 (0.316)	-0.307 (0.348)	-0.412 (0.339)	0.073 (0.401)	**-0.293 (0.132)**
No Dizziness							
Completed IVR Call	-1.512 (1.254)	0.18e2 (0.28e5)	0.18e2 (0.22e5)	-1.735 (1.246)	0.18e2 (0.23e5)	-0.24e2 (0.40e5)	-1.122 (0.654)
Age	0.011 (0.009)	-0.009 (0.009)	**-0.024 (0.010)**	0.003 (0.010)	-0.002 (0.011)	-0.019 (0.011)	-0.005 (0.004)
Sex	0.224 (0.224)	0.013 (0.238)	**-0.569 (0.261)**	0.064 (0.260)	0.223 (0.286)	0.256 (0.286)	0.034 (0.103)
Hospital site	-0.019 (0.243)	-0.416 (0.251)	**-0.576 (0.281)**	**-0.523 (0.272)**	0.025 (0.313)	-0.429 (0.303)	**-0.320 (0.110)**
Bold values showed significant association (p < 0.05) between symptoms and the respective independent variables (IVR call, sex, site, and age)							

Medication -

Table 10 shows the association between medication compliance and the independent variables (including completed IVR call). Older patients are more likely to take their medication compared to younger patients, this is particularly true for week 4 (0.048 (0.024)) as there is a significant association between taking medication and age. Younger patients are more likely to continue to take betablockers than older patients. This is especially true for weeks 2-12 combined (-0.011 (0.006)). Patients from UOHI are more likely to continue to take ACEI/ARB than rural and community hospital patients. This is especially true for week 2 (0.942 (0.372)), week 6 (1.043 (0.464)), week 10 (1.336 (0.525)) and weeks 2 to 12 combined (0.769 (0.185)).

Weight -

Table 11 shows the association between weight compliance and the independent variables (including completed IVR call). Patients who complete the IVR call are more likely to weigh themselves daily. This is particularly true for week 2 (0.695 (0.296)) and weeks 2-12 combined 3.028 (1.433)) as there is a significant association between weight compliance and completed IVR call. Older patients were more likely to not weigh themselves every day, this is especially true for weeks 2-12 combined (-0.017 (0.005)). UOHI patients are more likely to weigh themselves daily, there is a significant association between daily weighing and hospital site over the 12-week call period (excluding weeks 8 and 10) as well as weeks 2-12 combined.

As for weight gain, patients that completed the IVR call were more likely to not gain weight, this is especially true for week 4 (0.29e2 (0.604)) where there was a significant association between completed IVR call and weight gain. Older patients were more likely to report weight gain. There is a significant association between daily weighing and hospital site over the 12-week call period (excluding weeks 2 and 4) as well as weeks 2-12 combined. Male patients are more likely to gain

weight, this is especially true for week 6 (-0.686 (0.374)), week 12 (-1.068 (0.459)) and weeks 2-12 combined (-0.401 (0.141)) where there was a significant association between sex and weight gain. UOHI patients are more likely to gain weight than other rural and community hospital patients. This is especially true for week 10 (0.244 (0.398)) where there was a significant association between hospital site and weight gain.

Table 10. Binary logistic regression showing the association between medication compliance (taking medication, taking betablockers and ACEI/ARB) and the respective independent variables (IVR call, age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Took Medication							
Completed IVR Call	0.012 (0.23e5)	0.15e2 (0.28e5)	0.151 (0.22e5)	0.327 (0.23e5)	-0.087 (0.22e5)	0.071 (0.40e5)	0.13e2 (0.10e5)
Age	0.006 (0.016)	**0.048 (0.024)**	-0.034 (0.021)	0.017 (0.022)	0.051 (0.033)	-0.036 (0.030)	0.008 (0.009)
Sex	0.305 (0.410)	-0.104 (0.497)	-0.711 (0.570)	-0.455 (0.564)	0.598 (0.651)	-0.279 (0.744)	-0.045 (0.217)
Hospital site	0.158 (0.443)	-0.114 (0.509)	0.334 (0.704)	1.178 (0.793)	-0.548 (0.631)	-1.088 (0.775)	-0.053 (0.236)
Took Betablockers							
Completed IVR Call	-0.281 (0.40e5)	-0.15e2 (0.40e5)	0.079 (0.28e5)	-0.206 (0.23e5)	-0.182 (0.40e5)	-0.402 (0.40e5)	-0.14e2 (0.13e5)
Age	-0.020 (0.012)	-0.005 (0.012)	-0.003 (0.015)	-0.025 (0.016)	-0.005 (0.015)	-0.008 (0.017)	**-0.011 (0.006)**
Sex	-0.531 (0.285)	-0.154 (0.299)	-0.367 (0.344)	-0.441 (0.399)	0.479 (0.355)	-0.210 (0.407)	-0.231 (0.137)
Hospital site	0.248 (0.289)	0.165 (0.305)	0.071 (0.374)	-0.245 (0.444)	0.024 (0.379)	0.511 (0.417)	0.147 (0.144)
Took ACEI/ARB							
Completed IVR Call	0.19e2 (0.33e4)	0.061 (0.40e5)	0.0115 (0.40e5)	0.179 (0.28e5)	-0.19e2 (0.28e4)	0.19e2 (0.28e4)	0.025 (0.20e5)
Age	-0.006 (0.015)	-0.013 (0.016)	-0.027 (0.020)	0.003 (0.016)	0.008 (0.021)	-0.023 (0.027)	-0.008 (0.007)
Sex	-0.328 (0.373)	-0.282 (0.388)	-0.349 (0.448)	0.423 (0.427)	-0.046 (0.502)	-0.046 (0.578)	-0.122 (0.176)
Hospital site	**0.942 (0.372)**	0.628 (0.393)	**1.043 (0.464)**	0.009 (0.518)	**1.336 (0.525)**	0.663 (0.626)	**0.769 (0.185)**
Bold values showed significant association ($p < 0.05$) between medication compliance and the respective independent variables (sex, site and age)							

Table 11. Binary logistic regression showing the association between weight compliance (daily weighing and weight gain) and the respective independent variables (IVR call, age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Daily Weighing							
Completed IVR Call	**0.695 (0.296)**	0.290 (0.324)	**0.831 (0.338)**	0.23e2 (0.40e5)	-0.17e2 (0.40e5)	0.643 (0.351)	**3.028 (1.433)**
Age	-0.011 (0.011)	-0.019 (0.014)	0.003 (0.013)	-0.023 (0.013)	-0.035 (0.015)	-0.016 (0.015)	**-0.017 (0.005)**
Sex	-0.374 (0.272)	0.054 (0.316)	-0.215 (0.334)	-0.035 (0.302)	0.003 (0.316)	-0.177 (0.360)	-0.135 (0.127)
Hospital site	**1.051 (0.273)**	**1.200 (-0.320)**	**0.670 (0.344)**	0.516 (0.311)	0.668 (0.318)	**0.790 (0.361)**	**0.812 (0.128)**
No Weight gain							
Completed IVR Call	19.4 (0.26e4)	**0.29e2 (0.604)**	0.19e2 (0.23e4)	0.14e2 (0.40e5)	0.589 (0.40e5)	0.19e2 (0.22e4)	0.15e2 (0.28e5)
Age	-0.013 (0.012)	-0.012 (0.012)	**-0.045 (0.015)**	**-0.039 (0.013)**	**-0.025 (0.014)**	**-0.042 (0.017)**	**-0.027 (0.005)**
Sex	0.020 (0.318)	-0.358 (0.307)	**-0.686 (0.374)**	-0.297 (0.342)	-0.238 (0.357)	**-1.068 (0.459)**	**-0.401 (0.141)**
Hospital site	0.307 (0.375)	-0.011 (0.336)	-0.127 (0.434)	-0.097 (0.396)	**0.244 (0.398)**	0.427 (0.521)	0.116 (0.162)
Bold values showed significant association ($p < 0.05$) between the weight compliance and the respective independent variables (sex, site and age)							

Lifestyle -

Table 12 shows the association between patient lifestyle and the independent variables (including completed IVR call). Patients who complete the IVR call are more likely to not use a saltshaker. This is particularly true for week 12 (1.554 (0.462) as there is a significant association between completed IVR call and not using a saltshaker. Older patients were more likely to not use a saltshaker, this is especially true for weeks 2-12 combined (0.023 (0.006)). Male patients are more likely to not use a saltshaker, there is a significant association between sex and not using a saltshaker at week 6 (1.132 (0.481)).

Patients who complete the IVR call are more likely to eat processed food. This is particularly true for week 4 (-0.635 (0.266)) as there is a significant association between completed IVR call and eating processed food. Older patients were more likely to not eat processed than younger patients, this is especially true for week 12 (0.026 (0.012)) and weeks 2-12 combined (0.011 (0.004)). UOHI patients are more likely to eat processed food, there is a significant association between hospital site and eating processed food at week 10 (-0.682 (0.287)) and weeks 2-12 combined (-0.310 (0.114)).

Patients who complete the IVR call are more likely to drink more than 8 cups of fluid a day. This is particularly true for week 8 (-3.430 (1.465)) and week 12 (-0.964 (0.330)) as there is a significant association between completed IVR call and drinking more than 8 cups a day. Older patients were more likely to drink more than 8 cups of fluid a day, this is especially true for weeks 2-12 combined (-0.010 (0.005)). UOHI patients are more likely to drink more than 8 cups a day, there is a significant association between the variables at week 6 (-0.948 (0.317)) and weeks 2-12 combined (-0.468 (0.134)).

Patients who complete the IVR call are more likely to read food labels, there is a significant association between completed IVR calls and reading food labels over the 12-week call period (excluding weeks 8 and 10) as well as weeks 2-12 combined. Older patients were more likely to not read food labels, this is especially true for week 4 (-0.034 (0.012)), week 8 (-0.040 (0.013)), week 10 (-0.029 (0.014)) and weeks 2-12 combined (-0.023 (0.005)). Male patients are more likely not to read food labels, there is a significant association between the sex and reading food labels at week 2 (-0.697 (0.277)). UOHI patients are more likely to read food labels than rural and community hospital patients. This is particularly true at week 2 (0.693 (0.274)) and weeks 2-12 combined (0.353 (0.124).

Patients who complete the IVR call are more likely to eat out safely, there is a significant association between completed IVR calls and reading food labels over the 12-week call period (excluding week 10). Older patients were more likely to not eat out safely, this is especially true for week 12 (-0.067 (0.020)) and weeks 2-12 combined (-0.012 (0.005)).

Patients who complete the IVR call are more likely to join a walk/activity program, there is a significant association between completed IVR calls and patients in a walk/activity program over the 12-week call period as well as weeks 2-12 combined. Older patients were more likely to not be part of a walk/activity program, this is especially true for week 2 (-0.015 (0.007)) and weeks 2-12 combined (-0.011 (0.003)). Male patients are more likely to join a walk/activity program than female patients. UOHI patients are more likely join a walk/activity program than rural and community hospital patients. There is a significant association between sex and walk/activity program as well as hospital site and walk/activity program over the 12-week call period.

Table 12. Binary logistic regression showing the association between patient lifestyle (using saltshaker, eating processed food, drinking more than 8 cups of fluid, reading food labels, eating out safely and joining a walk/activity program) and the respective independent variables (IVR call, age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Not using Saltshaker							
Completed IVR Call	0.18e2 (0.40e5)	-0.508 (0.354)	0.16e2 (0.40e5)	0.17e2 (0.28e5)	0.17e2 (0.40e5)	**1.554 (0.462)**	0.17e2 (0.17e5)
Age	**0.022 (0.011)**	0.027 (0.014)	0.030 (0.018)	0.024 (0.015)	0.006 (0.018)	0.030 (0.019)	**0.023 (0.006)**
Sex	-0.435 (0.273)	0.091 (0.345)	**1.132 (0.481)**	0.321 (0.363)	-0.291 (0.430)	0.262 (0.435)	0.071 (0.147)
Hospital site	-0.118 (0.304)	0.434 (0.402)	0.141 (0.467)	0.283 (0.410)	-0.153 (0.457)	-0.094 (0.458)	0.097 (0.162)
Not eating processed food							
Completed IVR Call	0.18e2 (0.40e5)	**-0.635 (0.266)**	-0.23e2 (0.40e5)	0.19e2 (0.28e5)	0.18e2 (0.40e5)	-0.441 (0.279)	-0.858 (1.123)
Age	-0.001 (0.009)	0.016 (0.010)	0.016 (0.010)	0.012 (0.011)	0.004 (0.011)	**0.026 (0.012)**	**0.011 (0.004)**
Sex	-0.005 (0.242)	0.184 (0.260)	-0.148 (0.251)	-0.338 (0.266)	0.142 (0.282)	-0.262 (0.279)	-0.067 (0.106)
Hospital site	-0.162 (0.271)	-0.123 (0.278)	-0.137 (0.274)	-0.290 (0.283)	**-0.682 (0.287)**	-0.513 (0.292)	**-0.310 (0.114)**
No more than 8 cups of fluid							
Completed IVR Call	0.18e2 (0.40e5)	-0.427 (0.296)	-0.049 (0.303)	**-3.430 (1.465)**	0.18e2 (0.40e5)	**-0.964 (0.330)**	-1.672 (1.162)
Age	0.006 (0.010)	-0.020 (0.011)	-0.010 (0.012)	-0.011 (0.013)	-0.015 (0.012)	-0.014 (0.013)	**-0.010 (0.005)**
Sex	-0.004 (0.264)	0.229 (0.304)	0.036 (0.309)	0.141 (0.346)	-0.230 (0.320)	-0.001 (0.336)	0.028 (0.126)
Hospital site	-0.245 (0.289)	-0.569 (0.320)	**-0.948 (0.317)**	-0.074 (0.389)	-0.443 (0.338)	-0.547 (0.356)	**-0.468 (0.134)**
Reading food labels							
Completed IVR Call	**1.310 (0.330)**	**0.585 (0.282)**	**1.317 (0.314)**	0.23e2 (0.40e5)	-0.17e2 (0.40e5)	**1.037 (0.334)**	**2.980 (1.443)**
Age	-0.014 (0.010)	**-0.034 (0.012)**	-0.022 (0.012)	**-0.040 (0.013)**	**-0.029 (0.014)**	0.002 (0.013)	**-0.023 (0.005)**
Sex	**-0.697 (0.277)**	0.067 (0.269)	0.129 (0.283)	0.356 (0.291)	0.107 (0.322)	-0.422 (0.353)	-0.080 (0.118)
Hospital site	**0.693 (0.274)**	0.379 (0.280)	0.362 (0.299)	0.020 (0.314)	0.410 (0.331)	0.170 (0.375)	**0.353 (0.124)**
Eating out safely							
Completed IVR Call	**2.831 (0.469)**	**1.729 (0.299)**	**2.276 (0.417)**	**2.401 (0.418)**	-0.17e2 (0.40e5)	**2.044 (0.445)**	-0.17e2 (0.40e5)
Age	-0.009 (0.009)	-0.001 (0.010)	-0.001 (0.012)	-0.020 (0.012)	-0.017 (0.015)	**-0.067 (0.020)**	**-0.012 (0.005)**
Sex	0.098 (0.237)	0.297 (0.243)	0.209 (0.298)	0.111 (0.306)	-0.568 (0.358)	-0.353 (0.392)	0.028 (0.117)

Hospital site	-0.234 (0.271)	0.038 (0.267)	0.280 (0.327)	-0.284 (0.352)	0.611 (0.350)	-0.323 (0.429)	-0.005 (0.129)
Joined a walking/activity program							
Completed IVR Call	**1.355 (0.204)**	**1.012 (0.192)**	**1.360 (0.205)**	**1.354 (0.210)**	**0.932 (0.207)**	**1.182 (0.212)**	**1.188 (0.082)**
Age	**-0.015 (0.007)**	-0.007 (0.007)	-0.011 (0.008)	-0.011 (0.008)	-0.014 (0.009)	-0.011 (0.008)	**-0.011 (0.003)**
Sex	**0.396 (0.189)**	**0.544 (0.190)**	**0.586 (0.205)**	**0.412 (0.209)**	0.362 (0.211)	0.266 (0.214)	**0.430 (0.082)**
Hospital site	**0.475 (0.214)**	**0.528 (0.210)**	**0.944 (0.229)**	**1.104 (0.227)**	**1.002 (0.221)**	0.376 (0.236)	**0.728 (0.090)**
Bold values showed significant association ($p < 0.05$) between patient lifestyle choices and the respective independent variables (sex, site and age)							

Readmission -

Table 13 shows the association between readmission and the independent variables (including completed IVR call). Male patients are more likely to be readmitted. This is particularly true for week 10 (0.932 (0.380)) as there is a significant association between sex and readmission.

Table 14 shows the association between readmission and the variables assessed in the study (excluding completed IVR call). Patients who had difficulty breathing were more likely to be readmitted. This is particularly true for week 4 (-1.615 (0.549)) as there is a significant association between difficulty breathing and readmission. Patients who had reported dizziness were more likely to be readmitted. This is particularly true for week 4 (-1.615 (0.549)), week 10 (-1.829 (0.751)), and weeks 2-12 combined (-0.883 (0.255)), as there is a significant association between dizziness and readmission.

Patients who continue to take ACEI/ARB were less likely to be readmitted than patients who stopped taking ACEI/ARB. This is particularly true for week 6 (-2.070 (0.860)), week 12 (-2.787 (1.469)), and weeks 2-12 combined (-0.764 (0.344)), as there is a significant association between ACEI/ARB and readmission.

Patients who don't use saltshaker are less likely to be readmitted. This is particularly true for week 12 (-3.406 (1.000)) and weeks 2-12 combined (-0.676 (0.323)), as there is a significant association between not using saltshaker and readmission.

Patients who don't drink more than 8 cups of fluid a day are less likely to be readmitted. This is particularly true for week 8 (-3.811 (0.940)) as there is a significant association between the variables. Patients who eat out safely are less likely to be readmitted. This is particularly true for week 10 (-1.997 (0.921)) as there is a significant association between the variables.

Patients who have joined a walking/activity program are less likely to be readmitted. This is particularly true for week 8 (-2.253 (0.876)), week 10 (-2.002 (0.680)), week 12 (-1.566 (0.755)) and weeks 2-12 combined (-0.712 (0.218)), as there is a significant association between the variables. Older patients are more likely to be readmitted. This is particularly true for week 6 (0.061 (0.023)) and weeks 2-12 combined (0.013 (0.008)), as there is a significant association between age and readmission. Male patients are more likely to not be readmitted. This is particularly true for week 8 (2.303 (1.172)) as there is a significant association between age and readmission. UOHI patients are more likely to not be readmitted. This is particularly true for week 8 (3.281 (1.652)) as there is a significant association between hospital site and readmission.

Table 13. Binary logistic regression showing the association between readmission and the respective independent variables (IVR call, age, sex, and site) over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Readmission							
Completed IVR Call	0.19e2 (0.26e4)	0.19e2 (0.25e4)	0.19e2 (0.24e4)	0.19e2 (0.23e4)	0.19e2 (0.23e4)	0.19e2 (0.22e4)	0.19e2 (0.98e2)
Age	0.009 (0.012)	-0.001 (0.012)	0.006 (0.014)	-0.015 (0.014)	0.007 (0.015)	0.004 (0.018)	0.002 (0.006)
Sex	0.039 (0.309)	-0.137 (0.303)	0.303(0.340)	0.397 (0.376)	**0.932 (0.380)**	0.104 (0.445)	0.229 (0.141)
Hospital site	0.051 (0.341)	0.071 (0.329)	0.280 (0.395)	0.023(0.437)	-0.167 (0.381)	0.432 (0.509)	0.083 (0.156)
Bold values showed significant association (p < 0.05) between readmission and the respective independent variables (sex, site and age)							

Table 14. Binary logistic regression showing the association between readmission and the respective variables assessed in the study over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Readmission							
No Difficulty Breathing	-1.241 (0.804)	**-1.615 (0.549)**	0.141 (1.174)	0.727 (0.989)	0.698 (1.033)	-0.346 (1.128)	-0.505 (0.286)
No Ankle Swelling	1.030 (1.344)	1.632 (0.994)	0.144 (0.964)	-0.462 (1.151)	0.080 (1.466)	-1.454 (1.231)	0.288 (0.375)
No Dizziness	0.553 (0.881)	**-2.077 (0.532)**	-0.964 (0.819)	-1.341 (0.921)	**-1.829 (0.751)**	1.181 (1.462)	**-0.883 (0.255)**
Took Medication	-0.547 (1.143)	0.20e2 (0.13e5)	0.19e2 (0.12e5)	-1.235 (1.426)	0.19e2 (0.17e5)	0.21e2 (0.23e5)	0.816 (0.632)
Took Betablockers	-0.899 (0.689)	-0.600 (0.694)	1.550 (1.316)	0.471 (2.497)	-1.728 (1.157)	2.569 (1.920)	-0.293 (0.339)
Took ACEI/ARB	-0.566 (0.782)	-1.078 (0.744)	**-2.070 (0.860)**	0.633 (2.339)	1.909 (1.722)	**-2.787 (1.469)**	**-0.764 (0.344)**
Daily Weighing	-1.318 (0.727)	-0.926 (0.739)	0.19e2 (0.75e4)	-0.558 (1.293)	0.472 (1.026)	0.627 (1.449)	-0.102 (0.323)
No Weight gain	-1.256 (0.713)	-1.138 (0.679)	0.798 (1.309)	-0.966 (0.964)	-0.545 (0.814)	-1.158 (1.320)	-0.549 (0.298)
Not using Saltshaker	0.18e2 (0.72e4)	-0.833 (0.721)	-0.462 (0.981)	-1.137 (1.073)	0.228 (1.388)	**-3.406 (1.000)**	**-0.676 (0.323)**
Not eating processed food	0.007 (0.745)	-0.538 (0.643)	0.661 (0.865)	1.492 (1.479)	-0.019 (0.964)	1.355 (1.358)	0.099 (0.296)
No more than 8 cups of fluid	0.736 (1.143)	1.400 (0.950)	-0.229 (0.937)	**-3.811 (0.940)**	-0.977 (0.894)	-0.529 (1.089)	-0.530 (0.290)
Reading food labels	-0.249 (0.730)	-0.145 (0.681)	0.739 (0.789)	-1.022 (1.268)	1.043 (1.152)	0.19e2 (0.73e4)	0.022 (0.312)
Eating out safely	0.301 (0.675)	-0.134 (0.550)	0.848 (0.666)	0.356 (1.176)	**-1.997 (0.921)**	-1.355 (1.365)	-0.435 (0.261)

Joined a walking/activity program	-0.0005 (0.581)	-0.895 (0.487)	0.072 (0.637)	**-2.253 (0.876)**	**-2.002 (0.680)**	**-1.566 (0.755)**	**-0.712 (0.218)**
Age	0.003 (0.021)	0.007 (0.019)	**0.061 (0.023)**	-0.038 (0.033)	-0.034 (0.027)	-0.035 (0.030)	**0.013 (0.008)**
Sex	-0.056 (0.564)	0.783 (0.542)	0.718 (0.561)	**2.303 (1.172)**	0.555 (0.715)	0.216 (0.749)	0.605 (0.228)
Hospital site	0.177 (0.689)	0.531 (0.612)	1.158 (0.768)	**3.281 (1.652)**	-0.587 (0.744)	0.139 (0.898)	0.462 (0.263)
Bold values showed significant association ($p < 0.05$) between readmission and the variables assessed in the study.							

Table 15 shows the association between readmission and the variables assessed in the study (including completed IVR call). Of the patients who have completed the IVR call, those that reported no occurrence of dizziness were less likely to be readmitted. This is particularly true for week 4 (-1.808 (0.569)) and weeks 2-12 combined (-0.618 (0.255)), as there is a significant association between dizziness and readmission.

Patients who continued to take betablockers were less likely to be readmitted than patients who stopped taking betablockers. This is particularly true for week 6 (2.679 (1.202)) and week 12 (3.060 (1.555)) as there is a significant association between betablockers and readmission in patients who completed the IVR calls.

Of the patients who have completed the IVR call, those that don't use a saltshaker are less likely to be readmitted. This is particularly true for week 12 (-2.405 (1.104)) as there is a significant association between not using saltshaker and readmission. Patients who don't drink more than 8 cups of fluid a day are less likely to be readmitted. This is particularly true for week 8 (-3.110 (0.967)) as there is a significant association between the variables. Patients who have joined a walking/activity program are less likely to be readmitted. This is particularly true for week 10 (-1.605 (0.770)) as there is a significant association between the variables.

Older patients that completed the IVR call were more likely to be readmitted. This is particularly true for week 6 (0.067 (0.032)) and weeks 12 (0.084 (0.042)), as there is a significant association between age and readmission. Male patients are more likely to be readmitted. This is particularly true for weeks 2-12 combined (0.554 (0.231)) as there is a significant association between sex and readmission. UOHI patients are more likely to be readmitted. This is particularly true for week 8 (4.086 (2.165)) as there is a significant association between hospital site and readmission.

Table 15. Binary logistic regression showing the association between readmission and the respective variables (including completed IVR Call) assessed in the study over the 12-week call period and weeks 2 to 12 combined.

	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Weeks 2 – 12 Combined
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Readmission							
Completed IVR Call	-0.19e2 (0.35e4)	-0.19e2 (0.33e4)	-0.20e2 (0.31e4)	-0.19e2 (0.27e4)	0.19e2 (0.30e4)	-0.20e2 (0.29e4)	-0.19e2 (0.13e4)
No Difficulty Breathing	-0.730 (0.774)	-1.002 (0.545)	1.425 (1.167)	1.672 (1.036)	1.521 (1.025)	0.291 (0.997)	0.153 (0.279)
No Ankle Swelling	0.749 (1.196)	1.364 (0.916)	1.067 (0.947)	0.594 (1.273)	0.987 (1.322)	0.360 (1.249)	0.506 (0.346)
No Dizziness	0.623 (0.862)	**-1.808 (0.569)**	-0.7651 (0.926)	-2.077 (1.177)	-1.422 (0.841)	2.058 (1.493)	**-0.618 (0.255)**
Took Medication	0.093 (1.150)	0.21e2 (0.14e5)	0.20e2 (0.11e5)	-0.860 (1.355)	0.20e2 (0.18e5)	0.22e2 (0.24e5)	0.796 (0.560)
Took Betablockers	-0.139 (0.673)	-0.038 (0.656)	**2.679 (1.202)**	0.138 (1.854)	-0.413 (1.077)	**3.060 (1.555)**	0.378 (0.310)
Took ACEI/ARB	-0.346 (0.718)	-0.584 (0.694)	-1.100 (0.866)	1.620 (1.709)	1.706 (1.457)	-1.364 (1.334)	-0.212 (0.310)
Daily Weighing	-1.402 (0.764)	-0.900 (0.739)	0.20e2 (0.68e4)	-0.244 (1.485)	0.613 (1.269)	2.635 (1.940)	-0.110 (0.324)
No Weight gain	-0.608 (0.690)	-0.508 (0.650)	1.419 (1.183)	-0.116 (0.954)	0.314 (0.820)	0.971 (1.326)	0.036 (0.281)
Not using Saltshaker	0.18e2 (0.68e4)	-0.725 (0.782)	-0.177 (1.221)	-1.298 (1.200)	-0.266 (1.931)	**-2.405 (1.104)**	-0.484 (0.330)
Not eating processed food	-0.001 (0.735)	-0.650 (0.655)	1.012 (0.995)	0.816 (1.584)	-0.382 (1.281)	-0.265 (1.413)	-0.092 (0.294)
No more than 8 cups of fluid	0.896 (1.114)	1.463 (0.924)	-0.840 (1.256)	**-3.110 (0.967)**	-0.837 (1.137)	0.601 (1.205)	-0.377 (0.292)
Reading food labels	0.056 (0.751)	0.069 (0.663)	-0.502 (0.945)	-1.486 (1.481)	1.213 (1.266)	0.18e2 (0.70e4)	0.202 (0.303)
Eating out safely	0.887 (0.676)	0.234 (0.555)	0.419 (0.738)	0.809 (1.213)	-1.353 (0.938)	-1.341 (1.427)	0.116 (0.251)
Joined a walking/activity program	0.0238 (0.560)	-0.447 (0.510)	0.844 (0.707)	-1.529 (0.986)	**-1.605 (0.770)**	-0.498 (0.840)	-0.293 (0.218)
Age	-0.001 (0.023)	0.003 (0.0210	**0.067 (0.032)**	-0.041 (0.035)	-0.034 (0.030)	**0.084 (0.042)**	0.006 (0.009)
Sex	0.031 (0.581)	0.604 (0.553)	0.969 (0.661)	1.969 (1.274)	0.768 (0.772)	0.096 (0.862)	**0.554 (0.231)**
Hospital site	0.284 (0.677)	0.520 (0.618)	0.668 (0.794)	**4.086 (2.165)**	-0.843 (0.848)	-1.690 (1.372)	0.356 (0.270)
Bold values showed significant association ($p < 0.05$) between readmission and all the variables assessed in the study.							

8 Discussion -

Interactive voice response is an automated telephony system that leverages existing mobile and telephone lines for monitoring patient conditions. It is a low-cost innovative service that allows for early intervention (10,41). Despite the easy access to telephone services and growing familiarity with IVR, health care consumers are largely unaware of the technology's potential in the delivery of health care. Thus, IVR remains under researched and underdeveloped. There are only a few studies that have assessed the feasibility and reliability of IVR system in the diagnosis and management of chronic diseases.

This study aims to address the gap by exploring the pattern of IVR use by patients with HF and their compliance behavior when using this technology. Specifically, describing their characteristics and patterns of use, and investigating patient symptoms, differential compliance behavior (i.e., medication compliance, diet restriction, weight gain) and service utilization (i.e., hospital readmission).

8.1 IVR system pattern of use

After the initial peak of nurse call backs at week 2, there was a steady decline of call backs and an increase in completed calls, indicating stabilization. Patients have become familiar with the IVR system and less call backs were required. Week 2 was the first week the IVR system asked patients questions regarding symptoms, medication, weight gain, lifestyle, and readmission. With new unfamiliar questions, nurses had to call back a lot more patients to clarify questions and verify responses. Over the 12 weeks, results show an overall increase in medication adherence and a decrease in symptom occurrence, weight gain and readmission rates. The findings suggest that with consistent system use, IVR monitoring, and education strategies have a positive effect on HF patients.

It was found that the elderly patients and female patients were more likely to complete the IVR calls. The findings also show that patients from rural and community hospitals were more likely to complete the IVR call, suggesting that IVR could be used to target patients in rural areas who need frequent monitoring but do not have access to a local health centre or access to fast internet for telehealth monitoring.

8.2 The Health Belief Model –

To help interpret the findings of the research The Health Belief Model (52) was recruited. The Health Belief Model (HBM) is a theoretical model that can be used to guide health promotion and disease prevention programs (52). The model is based on the theory that a person's willingness to change their health behaviors is primarily due to their health perceptions. One application of the eminent model is to assist the understanding of compliance with treatments. Compliance is thought to be determined by the knowledge and attitudes of the patient (31,52).

According to the HBM, a patient's beliefs about health and health conditions play a role in determining health-related behaviors. Key factors that affect one's approach to health include: 1) how susceptible a person thinks they are to the illness, 2) knowing the consequences of becoming sick, 3) knowing the barriers that might stand in the patient's way, 4) how much benefit a person will gain by engaging in healthy behaviors, 5) exposure to information that prompts action, and 6) confidence in one's ability to succeed.

Figure 5 demonstrates a simplified version of the HBM to fit the variables of this study.

1) Perceived Severity - The probability that a person will change their health behaviors depends on how serious they believe the health consequences will be. The severity of an illness has a major impact on health outcomes. Perceived severity refers to a person's feelings on the seriousness of leaving the illness untreated (53). A person would often consider the medical

consequences when evaluating the severity, in this case it would be the possibility of being readmitted. However, several studies have shown that perceived risk severity is the least powerful predictor of whether people will engage in preventive health behaviors (53).

2) Perceived Susceptibility - People will not change their health behaviors unless they believe that they are at risk. Patients must believe that they are susceptible to the disease or that they have it, and that the disease has serious consequences on their well-being (52). The patients in this study have been admitted into the UOHI and have all been hospitalized and diagnosed with HF. Research suggests that perceived susceptibility to illness is an important predictor of preventive health behaviors (53).

3) Perceived Benefits - It's difficult to convince people to change a behavior if there isn't something in it for them. People don't want to give up something they enjoy if they don't also get something in return. For a higher rate of compliance, patients must believe that by following a particular set of health recommendations the threat or severity of the condition will be reduced (52). This was achieved using the IVR system and the educational prompts the patients hear in every call.

4) Perceived barriers - One of the major reasons people don't change their health behaviors is that they think doing so is going to be hard. Changing health behaviors can cost effort, money, and time (REF). The individual must be able and willing to overcome any barriers to continue the proposed health behaviors (54). When promoting health-related behaviors, finding ways to help people overcome perceived barriers is important. Disease prevention programs can often do this by increasing accessibility, reducing costs, or promoting self-efficacy beliefs (53).

The HBM further proposes that there are factors that modify these perceptions of threats and that there are cues that trigger the health-related behaviors. Modifying factors include demographic variables such as race, age, sex, and ethnicity as well as sociopsychological variables (personality, social class, and peer pressure) (54). Cue to action is the stimulus needed to trigger the decision-making process to accept a recommended health action (55). These cues can be external, such as the use of the IVR system that reminds the patients of the recommended protocols.

Perceptions, modifiers, and cues do not fully explain noncompliance; motivation toward receiving health care in general seems to play a significant role. Certain people are encouraged by health-related problems and are motivated toward receiving help, whereas others seem to be less so (54). A study showed that patients with minimal motivation regarding health care required a higher intensity cue to trigger health related behaviors. Results showed that specific interventions such as high intensity cueing may be more effective in influencing compliance in this group (54). On the other hand, motivated patients towards health care required lower intensity cueing, but complained about barriers as wait times and impersonal patient care from clinic staff. Elevating such barriers could improve compliance in the motivated group (54).

Due to the limited patient background information, this study was unable to collect data on patient psychological characteristics, health motivation and perceived barriers. With more information, the HBM can be used to assist the understanding of HF patient compliance with IVR system use. Since a motivated patient would not need the same level of cueing as an unmotivated patient, a physician could prescribe a less or more intense IVR algorithm depending on the patients' level of motivation. Future studies can use the HBM as a guide when choosing study variables, to examine if different HF patients show greater compliance with different IVR algorithms.

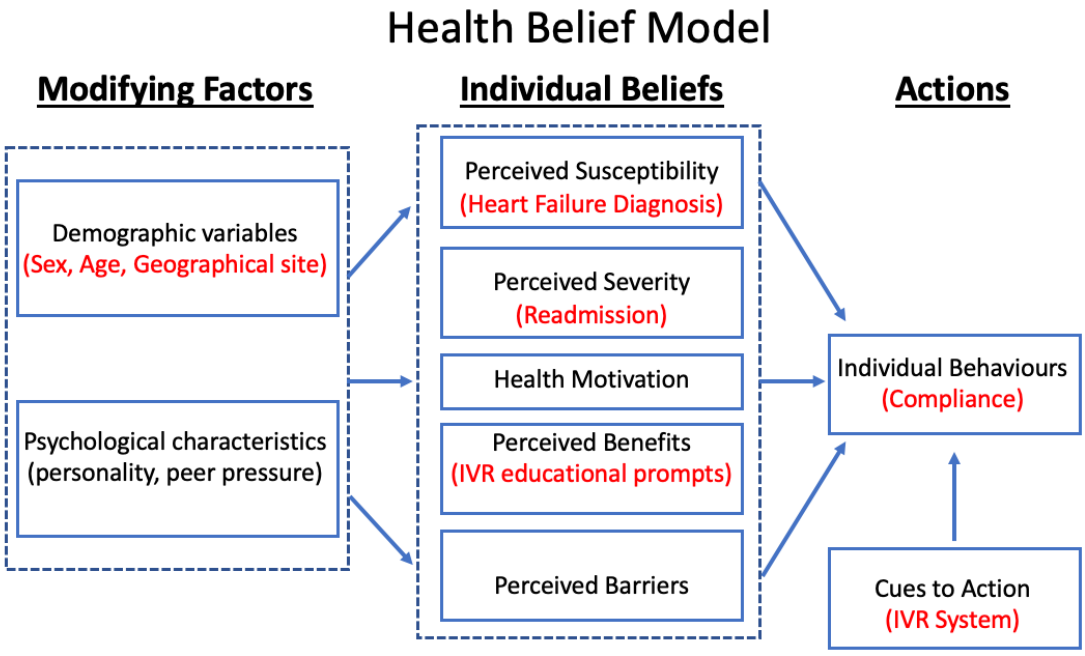


Figure 5. The Health Belief Model with the variables (in red) from this study.

8.3 IVR use, symptoms and compliance –

The highest compliance rate in this study was found in medication adherence. Similar results were found in other studies, where patients in the IVR group showed up to 60% improvement in medication compliance (43). This study further proves that a high rate of medication adherence in HF patients can be achieved with the use of IVR calls.

The lowest compliance rate in this study was found in the variable associated with exercise. All of sex, hospital site and age were found to be associated with not joining a walking/activity program. Although the IVR system reminds patients of the importance of joining an activity program, the compliance rate was low, as in other studies (30,31,56). A reason for the lack of compliance could be that the patients are in no physical condition to be part of such programs.

Results show that rural, older, female patients were less likely to join a walking/activity program (57). Urban/rural residency is an important predictor of participation in physical (57,58). Generally, women present relatively low rates of physical activity. Some factors that have been

associated with increased physical activity and walking among rural women have been street lighting, trust of neighbors, use of private recreational activities, having physically active neighbors, and having sidewalks (58). Lack of safety and amenities are factors that influence patients joining a walking/activity program. Interventions by rural and community hospitals might be necessary to HF patients, specifically to older, rural women, to help promote physical activity. Setting up an indoor track at the hospital and establishing a neighbourhood walking program would be helpful in motivating HF patients to walk with their neighbours in a safe, well-lit, warm location.

As for symptom occurrence, younger patients were found to more likely report the occurrence of ankle swelling, while older patients were reporting difficulty breathing and dizziness as symptoms. Based on the results describing medication compliance, older patients were found to be more compliant that younger patients, this could be because older patients often get more assistance with their medication regimen (31). Younger patients were more likely to weigh themselves every morning, whereas older patients and male patients were more likely to report that their weight has increased by more than 2 pounds in one day or more than 5 pounds in 1 week. According to the guidelines, patients with HF are advised to weigh themselves daily as weight gain is an important instrument for the detection of worsening HF (29).

With the lifestyle variables, it was found that older patients were more likely to not be complaint with the prescribed recommendations. Older patients were more likely to be found not restricting fluid intake, not reading food labels, and not eating out safely. With that said, younger patients were more likely to be using a saltshaker and eating processed food. As for joining a walking/activity program, it was found that older patients and female patients were less likely to

join such program. Patients from rural and community hospitals were also less likely to join an activity program.

Similar results were found in other studies (56), a high number of patients reported difficulty following dietary and exercise recommendations compared to other prescribed recommendations such as medication adherence and smoking cessation. The results showed that the inability to control the urge to drink more fluids and/or eat restricted foods was the most common reason that made following dietary recommendations difficult (53). Although some of these factors are disease related, lack of energy and presence of physical symptoms made following exercise recommendations more difficult.

8.4 Readmission –

Umehara et al. found that the average time it took for a HF patient to be re-hospitalized after discharge was 69.1 days, which was sooner than what past studies have reported (a range from 6 months to 1 year) (59). The researchers concluded that home visits or phone call follow-ups for 3 months after discharge might result in decreasing readmission rates in patients with HF (59). The results of this study reflect the researcher's suggestion. When looking at the 12-week overview of the trends, it was found that with increased use of IVR, risk of readmission decreased. This could be because a common reason behind readmission of HF patients is poor medication compliance. An increase in IVR use leads to an increase in medication adherence and a decrease in the risk of readmission.

When assessing the variables independently, it was found that age, symptoms, medication, and lifestyle were the determining variables for HF patient readmission. Results show that patients who reported symptoms of dizziness, stopped taking ACEI/ARB, were using a saltshaker and were not part of an activity program were more likely to get readmitted. Older patients were also more

likely to be readmitted. Similar results have been found where researchers concluded that the reason for readmission of patients with heart failure is poor administration of salinity and moisture, and poor medication management (59). There were no significant association between sex differences and risk of readmission. Most of the studies that included sex-based analyses showed no differences in readmission rates following HF hospitalization (60,61).

However, when controlling for IVR use, the results were different. Of the patients who completed the IVR calls, the determining variables for readmission were the occurrence of dizziness and sex. The risk of readmission for patients who completed the call, answered all the IVR questions and listened to the educational prompts was lower than the patients who were called back by a nurse. These results suggest that IVR calls do have a positive impact on HF patients, they promote compliance and reduce the risk of readmission. Moreover, the system worked better with females and younger patients than it did with males and older patients.

Based on the literature, it was surprising to see that weight gain was not a factor that determined readmission. However, Howie-Esquivel et al. investigated whether a 5 lb weight gain in 1-week increased risk for hospital readmission in HF patients (62). Results showed that a 5 lb weight gain was associated with emergency department (ED) visits but not with hospital admission (62). Rather, difficulty breathing (dyspnoea) was a better predictor for hospital admissions. It was concluded that daily tracking of dyspnoea symptoms may be an important add on to daily weight to prevent hospitalization (62). Difficulty breathing was not found to be a determining variable for readmission in this study. However, older, male, UOHI HF patients were more likely to report symptoms of difficulty breathing, and they were also more likely to have been readmitted, but no direct association was found.

Table 16 shows a summary of the study's results indicating what patient characteristic was found to more likely complete IVR call, have no symptom occurrence, comply with medication, weight, lifestyle recommendations and not be readmitted. The greater the total number at the bottom of the table is the more adherent the patient was to the IVR system and to the prescribed recommendations. The table shows that the IVR system worked best with younger, female, rural patients compared to older, male, UOHI patients.

Based on the analysis and the results of this study, I think IVR would work best on younger, rural, and female HF patients. These patients showed higher levels of completed IVR calls, higher levels of behaviour compliance and lower levels of service utilization (hospital readmission). I think an IVR system with a different algorithm would work better for older, male and UOHI patients. This group of patients showed lower levels of completed IVR calls, maybe a call protocol with less questions per call would work better to guarantee call answering and call completion. Lower levels of behaviour compliance were also reported. Intervention by the hospital or patient family might be necessary at this point to help and support patients through behavioural changes which in turn will lead to lower levels of service utilization.

Table 16. Summary of the study's results showcasing what patient characteristic were found to more likely complete IVR call, have no symptom occurrence, comply with medication, weight, and lifestyle recommendations, and not be readmitted.

	Male patients	Female patients	Younger patients	Older patients	UOHI patients	Rural and community hospitals patients
IVR Call						
Completed IVR call		X	X			X
No symptom occurrence						
No Difficulty Breathing		X	X			X
No Ankle Swelling		X		X		X
No Dizziness	X		X			X
Medication adherence						
Took Medication		X		X		X
Took Betablockers		X	X		X	
Took ACEI/ARB		X	X		X	
Weight compliance						
Daily Weighing		X	X		X	
No Weight gain		X	X			X
Lifestyle compliance						
Not using Saltshaker	X			X	X	
Not eating processed food		X		X		X
No more than 8 cups of fluid		X	X			X
Reading food labels	X		X		X	
Eating out safely	X		X			X
Joined a walking/activity program	X		X		X	
Readmission						
No readmission		X	X			X
Total	**5**	**11**	**12**	**4**	**6**	**10**

9 Limitations -

A limitation of the current study was that self-reported questionnaires were used to measure patient compliance. It is possible that patients overestimated their compliance due to the tendency to give socially desirable answers, which can lead to an underestimation of the problem. Since the patients in the study were hospitalized for HF, it is possible that it was difficult for them to admit that they did not comply with the prescribed recommendations.

Another limitation would be that patient comorbidities were not known. Comorbidities are a key factor in HF readmissions, Wideqvist et al., found that the risk for readmission in HF patients rose with increasing number of comorbidities (63). It would be interesting to see if comorbidities were controlled for, would IVR use still have had the same effect on patient compliance and risk of readmission.

Moreover, the study did not have patient heart classification data which would have assisted in comparing patient groups based on clinical conditions. Heart failure is influenced by several factors, thus making it difficult to extract the reason for readmission accurately. Future studies should include more variables such as heart classification and patient living conditions to further assess the patient state post discharge.

Fluctuations were seen in results of the study, but no accurate explanation can be found to explain the swings from week to week. This is because external variables were not controlled for and that may have influenced patient behaviour and compliance outside of the IVR system. Since the IVR system only asks yes/no questions, the patients did not get the chance to elaborate on why they did not comply with certain recommendations. By asking open ended questions, researchers would be able to investigate other factors that influence compliance week by week such as mental health state.

Lastly, the generalizability of the results may also be a limitation. Although the patients of the study came from multiple centers, the IVR system was embedded within organizations capable of implementing and supporting it. Nonetheless, IVR technology is accessible and can be easily implemented. The algorithms can be programed and incorporated into the technology to access more people.

10 Implications –

For the past 20 years, heart failure reduction has been a major goal of national health promotion and prevention planning efforts (64). Comprehensive discharge instruction for heart failure patients, is measured as one of the hospital quality indicators aimed at reducing heart failure (64). The Heart Failure Society of America guidelines recommends that all patients with HF receive pharmacological and non-pharmacological therapy to improve symptoms and survival rates (29). Non-compliance with medication and diet contributes to worsening HF symptoms, in many cases leading to hospitalization. The highest rates of non-compliance are found in diet and fluid restriction, daily weighing, and activity (29,56-57).

Based on the literature, telehealth technologies like IVR offer several advantages, including simplicity, and convenience (22,41-43). One of the main advantages of IVR is the significant cost savings compared to usual care. The technology can provide customers information and guidance without taking much time away from medical or administrative staff (41–43). IVR has been implemented in the treatment of patients with chronic cardiac problems (42). Patient use of IVR resulted in higher rates of adherence to antihypertensive medication, compared to the control group that did not use IVR (42). There are many factors such as age and gender, that may influence how a patient uses the IVR program and to this date, no prior study has investigated the differential use

and benefits of IVR among different groups of patients, which this study was successful in demonstrating.

Studies have shown that HF patients had knowledge deficit when it came to their deteriorating symptoms, and only a few patients knew that their symptoms were due to HF (66). In another study, patients were able to list HF symptoms and various selfcare strategies (43). However, many of them listed incorrect strategies such as drinking more water to reduce ankle swelling or having pickle juice to control blood pressure (43). Patients reported that lack of information from healthcare providers contributed to knowledge deficit of HF symptoms and self-care strategies (43, 58). An advantage of IVR is that HF patients can be asked monitoring questions but also be given educational prompts at the same time. Whatever a physician forgets to mention the IVR system would be programmed to reiterate the information and explain in further details. If a patient, has questions they would be able to put in a request for further clarification from a nurse.

There was consistency in the significant association between age and hospital site in terms of not taking beta blockers, not weighing themselves and the occurrence of symptoms. Older patients were more likely to not follow prescribed recommendations even though they were found to more likely complete the IVR call. A reason for this could be that older patients tend to be more forgetful. Older patients could be answering the IVR calls but forgetting to complete the assigned tasks. In this case, patients can be prescribed weekly IVR calls instead of bi-weekly to ensure that they are following recommendations. Text messages can also be sent to older patients after the IVR call has ended with reminders of the assigned tasks.

Based on the results from this study, IVR appealed to patients from rural and community hospitals. This implies that IVR can be used as a tool for remote monitoring patients in rural areas

who do not have access to advanced telehealth systems or easy access to health care. Previous studies have concluded that issues in broadband connectivity limit the reach and effectiveness of telehealth initiatives in rural areas (67). A recommendation for future studies would be to conduct a rural-urban comparison of IVR patient monitoring to investigate the impact of IVR in very rural areas.

IVR also appealed to younger and female HF patients. By exploring rate of patient compliance and service utilization in relation to IVR use, this study can be used as a guide to find out the characteristics that best fit a HF patient to use IVR, as the results show that different patient characteristics benefit differently from IVR.

11. Next steps

When developing an IVR compliance plan, it is useful to note that one version will not fit all, it is best to have multiple different versions of the algorithm and set up a group of patients with a specific algorithm. To improve compliance, it is important that hospitals such as the UOHI, consider all the variables that influence compliance, such as marital and living status, comorbidities, and depressive symptoms. The only variables that were assessed in this study were sex, age, and hospital site. By creating new IVR algorithms that fit the description of multiple patients, the results will be more significant as they would be more personalized to the patient. For example, an older male HF patient with three comorbidities who lives alone would not get the same set of IVR questions as a younger female HF patient who does not have any other diseases and lives with a caregiver.

Studies have shown that patients with better mental health were more compliant with diet, fluid restriction, and exercise (56). Programing the IVR system to provide HF patients with psychologic support messages that address dietary and exercise regimens may alleviate feelings of

difficulty patients may have in following medical recommendations. This may ultimately improve patient compliance behaviors.

Finally, the use of IVR in health care is not limited to heart failure patients. IVR can be used to support any patient, whether elderly, rural or immunocompromised. It is important to research different strategies in how to optimize the use of IVR technology in health care. IVR is affordable, accessible and has potential to prevent unnecessary hospitalization. Especially with recent events and stay at home orders due to COVID-19, patients feel unsafe going to a hospital for a routine check-up (68). There are various benefits in using IVR, especially in routine care and non-emergency cases where services do not require direct patient-provider interaction. Remote care reduces the use of resources in health centers, improves access to care, while minimizing the risk of direct transmission of infections, keeping patients and providers safe (68).

12 Conclusion -

This study explores the pattern of IVR use by HF patients at UOHI. The aim is to describe the patient characteristics and IVR pattern of use in relation to occurrence of symptoms, compliance behavior (e.g., weighing themselves, medication compliance) and services utilization (i.e., hospital readmission). Over the 12 weeks, results showed an overall increase in medication adherence and a decrease in symptom occurrence, weight gain and readmission rates. The highest compliance rate in this study was found in medication adherence and the lowest was found in the variable associated with exercise. The risk of readmission for patients who completed the IVR call, answered all the questions and listened to the educational prompts was lower than the patients who did not complete the call. These results suggest that IVR calls do have a positive impact on HF patients. The increased use of IVR in remote patient monitoring will allow for a cheaper and more accessible form of at home recovery. The pattern of IVR use may vary across patients, but there are benefits associated with the use of this technology in relation to HF patients' behavioral changes and readmissions. Leveraging IVR technology to support other conditions, especially during a pandemic, may be beneficial for patients to avoid unnecessary visits to the hospital and complications due to delay in seeking care.

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