Journal of Medical Systems (2022) 46: 69
https://doi.org/10.1007/s10916-022-01847-7

PATIENT FACING SYSTEMS

IVR System Use by Patients with Heart Failure: Compliance and Services Utilization Patterns

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Received: 2 February 2022 / Accepted: 25 July 2022 / Published online: 15 September 2022

Abstract

Heart failure (HF) is the leading cause of cardiovascular morbidity and health care utilization globally. Much of the cost for HF is related to hospitalization, strategies to decrease cost need to focus on avoiding unnecessary hospital readmission. Interactive voice response (IVR) is an automated telephony system that leverages existing telephone lines to monitor patients post-discharge, for early intervention. This study explores the pattern of IVR use by HF patients in the IVR program at the University of Ottawa Heart Institute (UOHI) and assesses IVR use by patients in relation to symptoms, compliance behavior, lifestyle, and hospital readmission. A total of 902 HF patients were considered; the mean age was 70 years, and 59.4% were male. Over a 12-week period of IVR use, there was an overall increase in medication adherence and a decrease in symptoms occurrence, weight gain and readmission rate. The highest and lowest compliance rates were associated with medication adherence and exercise, respectively. Overall, older, female patients from rural/community hospitals were more likely to complete the IVR calls, have less symptoms occurrence, comply with medications, weight, and lifestyle recommendations. The findings suggest that IVR system use can have a positive impact on HF patients' management. The increased use of IVR in remote patient monitoring will allow for a cheaper and more accessible form of 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.

Keywords Remote monitoring · Patient Compliance · Heart Failure · Service Utilization, Interactive Voice Response.

Introduction

Heart failure (HF) is a global pandemic that is increasing in prevalence and affecting at least 26 million people worldwide [1]. Around 5.7 million people in the US live with HF, and it is expected that by 2030 more than 8 million people will have this condition, representing a 46% increase [2]. HF prevalence in South America and Australia is also comparable at 1–2% of the population [3, 4], whereas in South Asia, its prevalence is even higher [5]. In Canada, frequent hospital readmissions make up a significant portion of HF management cost, and hospital admissions due to HF as the primary diagnosis cost reaching CAN$ 482 million in 2013; these costs are projected to increase to CAN$ 720 million by 2030 [2].

Since much of the cost associated with HF is related to hospitalization, strategies to decrease cost need to focus on avoiding unnecessary readmissions to hospital. While follow-up via telephone may improve disease management [7], studies have shown that clinician-delivered telephone care results in limited cost savings [8, 9]. 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 [10].

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 re-hospitalization rates and use of resources [11]. ICTs consist of technology (i.e., computers, video, phone, messaging) typically used by a medical professional

This article is part of the Topical Collection on *Patient Facing Systems*.

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to diagnose, treat, and monitor patients remotely [10, 11]. Specifically, structured telephone support using interactive voice response (IVR) uses an automated telephony system that leverages existing telephone lines to monitor patients post-discharge for early intervention [12].

IVR offers several advantages, including convenience, simplicity, and confidentiality in addition to significant cost savings compared to usual care and other forms of ICTs [12]. An IVR program is usually designed 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 then sent back and stored in a secure database. Depending on a patient's answer to a question, their response is flagged as no action is needed, call was not answered, or notify a nurse to intervene. In the latter instance, a nurse would call back the patient to provide assistance [12, 13].

A Cochrane review on automated telephone communication systems reported limited and inconsistent evidence concerning IVRs clinical value and impacts on clinical outcomes [14], with concerns about patients' inability to use IVR or the technology being perceived as limiting their contact with their physicians [14, 15]. Another systematic review on monitoring interventions using technology for patients with HF called for more research on IVR systems to provide robust conclusions on their effectiveness [16].

To date, limited evidence exists on the pattern of use and success of IVR use among patients with HF. This research addresses this gap by examining the patterns of IVR system use in relation to patient symptoms, differential compliance behavior (i.e., medication compliance, diet restriction, weight gain) and service utilization (i.e., hospital readmission) in relation to IVR use over a 12-week period.

Methods –

Study Design and Sample

A cross-sectional quantitative study was conducted to analyze secondary data that had been collected at the University of Ottawa Heart Institute (UOHI). The sample consisted of HF patients who were admitted to the UOHI (urban) or other four rural/community hospitals in the Ottawa region, were over the age of 18 years, with a diagnosis of HF, and enrolled in the IVR program during the period 2010–2019. Patients without access to a landline telephone or cellular service, with a disability preventing them from using a phone, or whose first language is not English, or French were not included in the sample.

IVR System

Patients receive automated telephone calls at a predetermined time for three months, with calls made at day 2, day 7, and weeks 2, 4, 6, 8, 10, 12 after discharge, from an automated IVR system (Fig. 1). Each call lasts about five to eight minutes. The algorithm asks a specific set of questions related to HF in a specific order, in the same way a clinician would assess a patient. The Registered Nurses who manage the IVR system review the responses and based on a patient's answers, they call the patient for a follow-up as required.

Variables and Measures

Table 1 presents an overview of the variables and measures considered in this study. Given the secondary nature of the data, this research was limited to the demographic variables available in the IVR system: Sex (M/F), hospital site (UOHI/Rural community hospital), and age (years). IVR system use was assessed as: "*Call Completed*" when a patient completes the IVR call, answers all the questions and does not require a callback from a nurse; "*Call Back*" when a patient completes the call but requires a call back from the nurse for a follow up; and "*No Contact*" when all attempts to reach a patient are exhausted (3 attempts per day over 2 days) and the patient could not be reached.

The IVR system asks three questions to assess the occurrence of symptoms: difficulty breathing, ankle swelling and dizziness. To assess medication compliance, the IVR system asks three questions: stopped taking medication, still taking Betablocker, and still taking ACEI/ARB.

To monitor weight gain, the IVR system asks 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.

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

Statistical Analysis

All analyses were carried out with SPSS statistical software version 22.0 (IBM Corp, Armonk, New York, USA). Descriptive analysis was conducted for the demographic variables, and a trend analysis was performed to examine the evolution of the variables considered in this study over a 12-week call period. Multivariate binary logistic regression

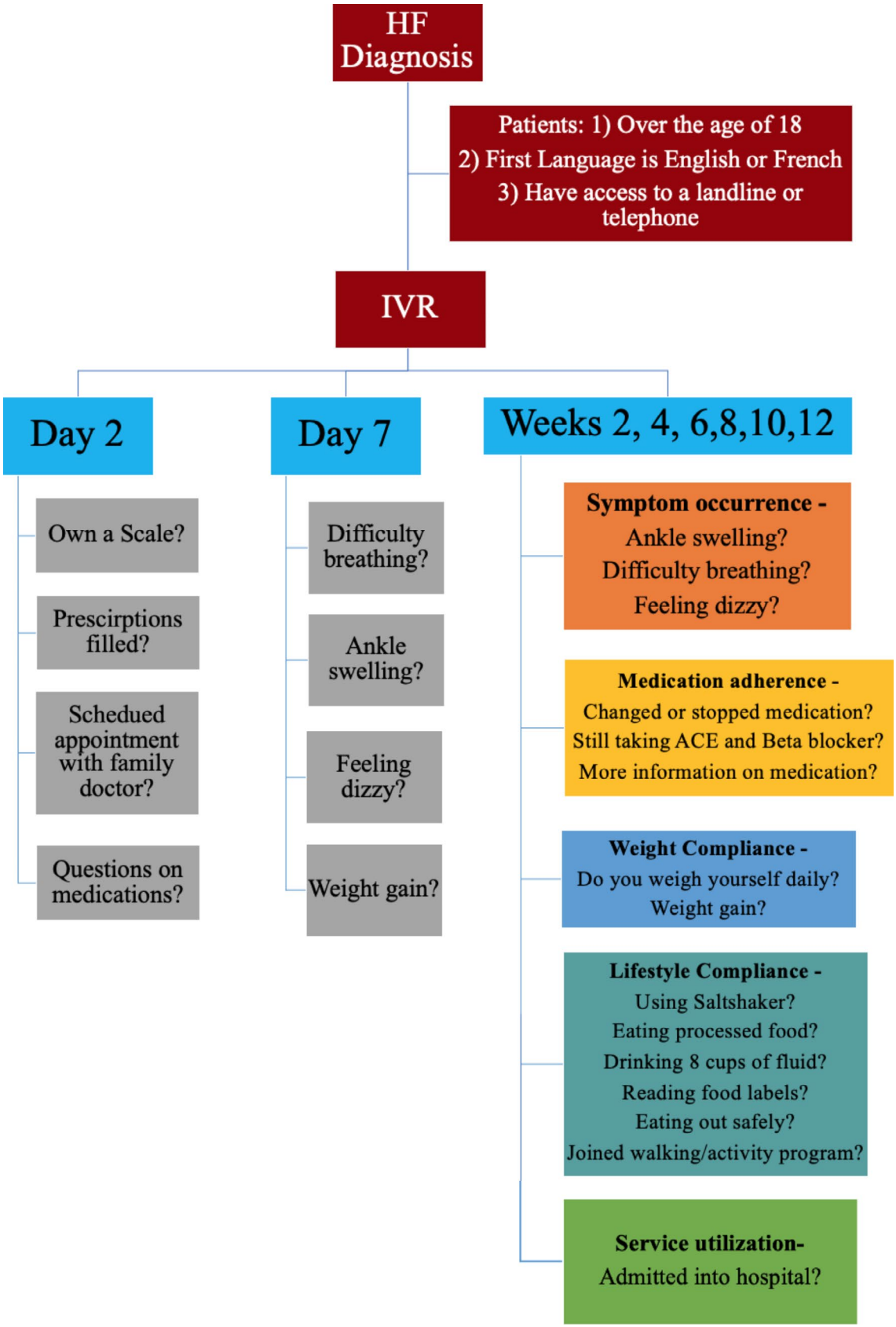

Fig. 1 Overview of the IVR system and its underlining algorithm

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) [a] Worsening or new ankle swelling (Y/N) [a] Dizziness (Y/N) [b]
Medication	Changed or stopped taking heart medication on your own (Y/N) [a] Stopped taking Betablocker (Y/N) [a] Stopped taking ACEI/ARB (Y/N) [a]
Weight	Do you weigh yourself daily? (Y/N) [c] Has your weight increased more than 2 pounds in one day or more than 5 pounds in 1 week? (Y/N) [a]
Lifestyle	Using saltshaker (Y/N) [b] Eating processed food (Y/N) [b] Drinking more than 8 cups of fluid per day (Y/N) [b] Reading food labels (Y/N) [c] Eating out safely (Y/N) [c] Joined a walking/activity program (Y/N) [c]
Readmission	Been readmitted since last call (2 weeks) (Y/N) [a]

[a] *Nurse is flagged to call patient back if patient answers question with 'Yes'*

[b] *Educational prompts are given to patient if patient answers question with 'Yes'*

[c] *Educational prompts are given to patient if patient answers question with 'No'*

analysis was performed to examine the relationship between service utilization (readmission) and symptoms occurrence, compliance (medication, weight, and lifestyle), and the demographic variables for each round of calls and the overall 12-week period. Post hoc analysis was performed to examine the relationship between service utilization (i.e., readmission) and symptoms occurrence, compliance (medication, weight, and lifestyle), and demographic variables, after controlling for IVR use. Interaction analysis was conducted with the demographic variables and the variables showing significant associations at the bivariate and multivariate levels of analysis. Statistical significance is defined as $p < 0.05$.

Table 2 Demographic characteristics of the patients included in sample

Variable	Patients (N = 902)
	N (%)
Sex	536 (59.4)
Male	366 (40.6)
Female	
Hospital Site	608 (67.4)
UOHI	294 (32.6)
Regional Community Hospitals	
Age (years)	73 ± 18
Median ± IQR	

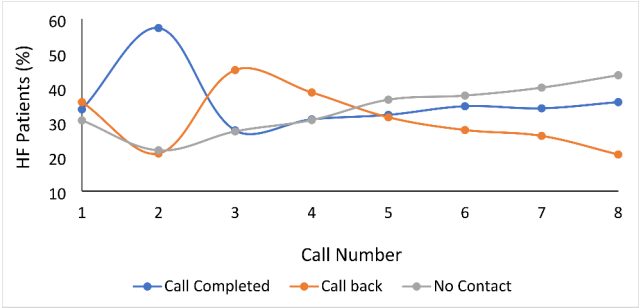

Fig. 2 Pattern of IVR system pattern of use among HF Patients at Day 2 (call 1), Day 7 (call 2) and Weeks 2–12 (calls 3–8)

Results

Study Population

In total, 902 patients were enrolled in the IVR program between 2010 and 2019 and were considered in this study. As seen in Table 2, more than half of the participants were male (59.4%), and the majority (67.4%) were urban patients. Patients' age ranged between 24 and 102 years (Median ± IQR = 73 ± 18).

Trends in IVR System Use

To compare the pattern of IVR system use, we examined the number of HF patients who *completed the IVR call, were called back by a nurse*, and were *not contacted by the IVR system* against the call number [1–8]. The highest rate of completed IVR calls (57%) occurred in Day 7 (call 2). Over the 12-week period (i.e., 8 calls in total), 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 the same i.e., 33.7% at week 2 (call 3) and 35.8% at week 12 (call 8) (Fig. 2).

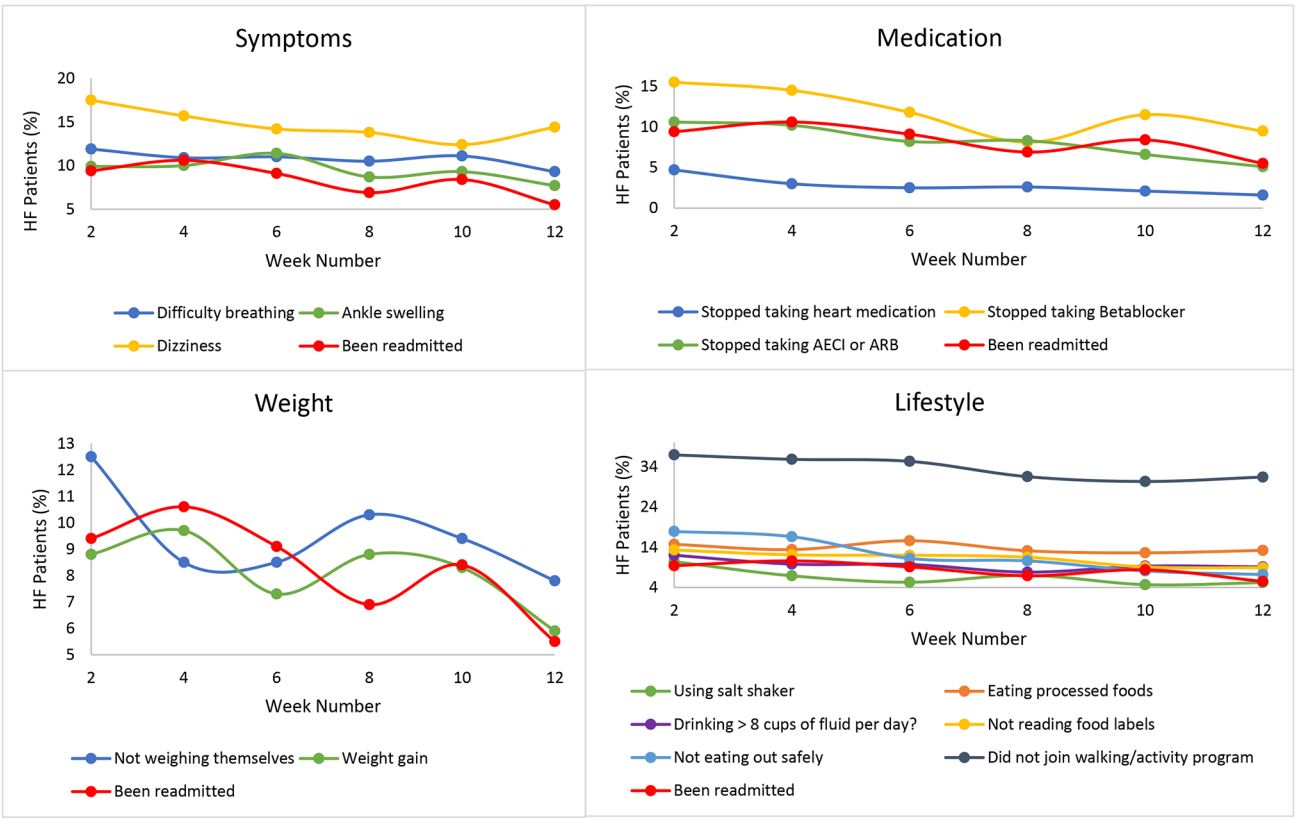

Fig. 3 Patterns of patient's response to IVR questions related to symptoms, medication, weight compliance and lifestyle plotted with pattern of readmission (red) over the 12-week call period

Patterns of Symptoms and Compliance

We examined the responses to questions across the period of calls from week 2 to week 12 (Fig. 3). In general, week 8 of IVR system use (post-discharge from the hospital) demonstrated the most negative changes in compliance with heart medications and weight compliance, and subsequently, week 10 revealed a peak in hospital readmissions. Two peaks in hospital readmission were identified at week 4 and week 10. It is important to note that, despite these specific peaks, a noticeable pattern of improvement in symptoms is observed from week 2 to week 12 of IVR system use (e.g., 10–7.7% reported worsening or new ankle swelling, respectively), which is paralleled by a higher medication adherence (e.g., 4.7–1.6% stopped taking their medications, respectively), and weight compliance (e.g., 8.8% and 5.5% reported weight gain, and 17.9% and 7.2% indicated not eating out safely, respectively).

Relationship between patient demographic variables and IVR system use, symptoms occurrence, compliance (medications, weight, and lifestyle) and readmission

First, multivariate logistic regression analysis was conducted to examine the relationship between the patient demographic variables (sex, age, and hospital site) and: IVR completed calls with no intervention; symptoms occurrence; and compliance (medication, weight, and lifestyle) (Table 3). Age was found to be significantly associated with most of the variables. Older age was associated with completed IVR calls, symptoms occurrence (difficulty breathing, less ankle swelling), medication compliance (not taking Betablockers), weight compliance (not weighing themselves daily, weight gain), and lifestyle variables (not using saltshaker, not eating processed food, not controlling their fluid intake, not reading food labels, not eating out safely, and not joining a walking/activity program).

With respect to sex, female patients were more likely to complete IVR calls and not report ankle swelling and weight gain; but they were less likely to join a walking/activity program.

Table 3 Binary logistic regression significant associations (at $p < 0.05$) between symptoms occurrence and compliance variables (medication, weight, and lifestyle) in relation to demographic variables and IVR use

	Weeks 2–12 Combined
	B (SE)
Completed IVR Call	
Age	0.018 (0.003)
Sex	-0.166 (0.072)
Hospital site	-0.200 (0.080)
No Difficulty Breathing	
Age	-0.020 (0.005)
No Ankle Swelling	
Age	0.022 (0.006)
Sex	-0.452 (0.127)
Hospital site	-0.293 (0.132)
No Dizziness	
Hospital site	-0.320 (0.110)
Took Betablockers	
Age	-0.011 (0.006)
Took ACEI/ARB	
Hospital site	0.769 (0.185)
Daily Weighing	
IVR use	3.028 (1.433)
Age	-0.017 (0.005)
Hospital site	0.812 (0.128)
No Weight gain	
Age	-0.027 (0.005)
Sex	-0.401 (0.141)
Not using Saltshaker	
Age	0.023 (0.006)
Not eating processed food	
Age	0.011 (0.004)
Hospital site	-0.310 (0.114)
No more than 8 cups of fluid	
Age	-0.010 (0.005)
Hospital site	-0.468 (0.134)
Reading food labels	
IVR use	2.980 (1.443)
Age	-0.023 (0.005)
Hospital site	0.353 (0.124)
Eating out safely	
Age	-0.012 (0.005)
Joined a walking/activity program	
IVR use	1.188 (0.082)
Age	-0.011 (0.003)
Sex	0.430 (0.082)
Hospital site	0.728 (0.090)
Only significant associations at $p < 0.05$ shown in table	

Last, patients from community/rural hospitals were more likely to complete the IVR call, report less symptoms (no ankle swelling and no dizziness), and diet compliance (not eating processed and limiting fluid intake). However, being a patient in a community/rural hospital was associated with less likelihood of taking ACEI/ARB, weighing themselves daily, reading food labels, and joining a walking/activity program. When an interaction analysis was run between the patient characteristics (sex, age, and site) with the outcome variables (symptoms, compliance, and lifestyle), no significant relationships were observed.

Second, multivariate logistic regression analysis was conducted to examine the association between readmission and symptoms occurrence and compliance (medication, weight, and lifestyle), while controlling for patient demographic variables (sex, age, and hospital site). Table 4 presents the significant associations found between the study variables and readmission. Over the period of weeks 2–12 combined, and after controlling for all other variables, increased readmission was associated with older age, the occurrence of dizziness, not taking ACEI/ARB, using saltshakers, and not joining a walking/activity program. Interestingly, not joining a walking/activity program was consistently significantly associated with increased readmission in weeks 8, 10 and 12.

Post hoc multivariate logistic regression analysis was further performed to examine the relationship between service utilization (readmission) and symptoms occurrence, compliance (medication, weight, and lifestyle), and demographic variables while controlling for completed IVR calls. In this case, the occurrence of dizziness and being a male patient were the only variables associated with increased readmission after controlling for IVR call completion and all other variables related to symptoms occurrence and compliance behavior (Table 5).

Discussion

The overall aim in the care of patients with chronic conditions is to improve compliance with treatment (medications and lifestyle modifications) which results in reduced symptoms and avoidance of costly readmissions.

Interactive voice response is an automated telephony system that leverages existing mobile and telephone lines for monitoring patient compliance and intervening as needed. It is a low-cost innovative service that allows for early intervention [7, 17]. This study investigates the pattern of IVR utilization, as well as the differential compliance behavior (i.e., medication compliance, diet restriction, weight gain) and unplanned hospital readmission among HF patients.

The compliance data demonstrate the challenges that patients face when learning new health behaviors. Patients clearly have ups and downs in relation to compliance, which have a direct impact on symptoms. Notably over the 12-week period, patients on the IVR system had an overall improvement in compliance, symptoms, and reduced readmissions. Although it is difficult to confirm it with

Table 4 Binary logistic regression for hospital readmission in relation to the respective variables assessed in the study over the 12-week call period

	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)	20 (13,000)	19 (12,000)	-1.235 (1.426)	19 (17,000)	21 (23,000)	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)	19 (7500)	-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	18 (7200)	-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)	19 (73,000)	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)

** Showed significant association ($p < 0.05$) between readmission and the variables assessed in the study.*

the current study design, there seems to be some learning acquired over time as reflected by the decreased number of necessary call backs, which potentially can impact patient symptoms and outcomes.

Older, female patients from rural/community hospitals were found to be more likely to complete the IVR calls than their counterparts. As such, IVR monitoring is an asset for patients, who need frequent monitoring and live outside major cities, and may not have access to specialized care and services. Strategies (e.g., education, advertising, etc.) to improve the response to IVR calls across the other groups should be developed to leverage the IVR remote monitoring technology for HF patient management.

A common reason behind readmission of HF patients is poor medication compliance. The highest compliance rate in this study was found in relation to medication adherence. When looking at the 12-week overview of the trends, it was found that, with increased use of IVR, the risk of unplanned readmission decreased. This may be due to the positive impact of IVR on medication and weight compliance. Similar findings have been reported with up to 60% improvement in medication compliance among patients in the IVR group [18].

The lowest compliance in this study was found in relation to exercise. The results show that being older and female patient from rural/community hospitals was associated with not joining a walking/activity program despite the reminders embedded in the IVR system (i.e., completed calls), which is in line with the results in other studies [19, 20]. The lack of amenities and safety are factors that influence patients joining a walking program [21], which signals a need for innovative strategies such as indoor walking tracks or establishing a neighbourhood walking programs to improve participation.

When controlling for IVR system use over the period of 12 weeks, only two variables (dizziness and sex) remained significantly associated with readmission. The occurrence of dizziness and being male were found to be associated with higher readmission. 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. Thus, keeping IVR call completion constant, no symptoms or compliance

Table 5 Binary logistic regression for readmission in relation to compliance (medication, weight and lifestyle), demographic characteristics, and IVR call for the 12-week call period

	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	-19 (3500)	-19 (3300)	-20 (3100)	-19 (2700)	19 (3000)	-20 (2900)	-19 (1300)
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)	21 (14,000)	20 (11,000)	-0.860 (1.355)	20 (18,000)	22 (24,000)	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)	20 (6800)	-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	18 (6800)	-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)	18 (7000)	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)

** Showed significant association ($p < 0.05$) between readmission and the variables assessed in the study.*

variables were significantly associated with readmission. This indicates that IVR call completion plays an important role by improving symptoms and promoting compliance among HF patients.

Based on the results of the study, the IVR system appears to work more effectively with older, female HF patients from rural/community hospitals. These patients showed higher levels of completed IVR calls, higher levels of behaviour compliance and lower levels of service utilization (hospital readmission). The findings can inform customized algorithms embedded in IVR system to best target HF patients with different profiles. Future research should explore strategies and IVR call protocols that would target younger, male, urban patients to improve system use and call completion.

According to the Health Belief Model (HBM), a theoretical model that can be used to guide health promotion and disease prevention programs and support the understanding of compliance with treatments [22, 23], patient motivation plays an important role in compliance. A motivated patient would not need the same level of cueing as an unmotivated patient. Thus, developing customizable IVR algorithm, which incorporates relevant data on the physiological state, motivation, and perceived barriers, would be suitable for different patient profiles. Future research should examine the relevant variables that should be incorporated and the variation in compliance with diverse customizable IVR algorithms.

A limitation of the study is the self-reporting nature of the IVR system. It is possible that patients overestimated their compliance due to the tendency to give socially desirable answers. The study did not have heart classification data, which is a good indicator of severity, and would have otherwise been informative in comparing patient groups based on their clinical condition. As a chronic condition, readmission for HF can be influenced by other social determinants

such as marital status, education etc. [24]. We recommend that future work on the IVR system focus on incorporating additional patient characteristics data to provide a more comprehensive overview of each case and enable more comprehensive analyses. The ability to add these variables into automated calling systems can be done at relatively low cost and should be considered to enhance the understanding of the impact of this technology on HF care.

It is important to note that hospital cost associated with HF is highly variable across organizations and age groups with an estimated mean of $10,123 [25]. It is estimated that by 2030, the cost in Canada associated with hospital admission due to heart failure will reach $CAN 720 million, out of which older adults account for 52% [6]. This further increases the burden on hospital resources caring for admitted HF patients. Technologies like the IVR system present opportunities to address these challenges. With increased compliance and decreased hospitalizations, the IVR technology can contribute to cost savings on the health care system level. This is in line with the results of a recent meta-analysis reporting that adherence to medications and lifestyle recommendations among HF patients can be improved by interventions (e.g., education, self-care, reminders and telemonitoring system), leading to 10% decreased likelihood of hospitalization within 12 months [26].

Despite the focus of this study on HF, the use of the IVR system may benefit patients with other health conditions. It is important to examine different strategies that can be implemented to optimize the benefits of IVR technology use in health care. IVR is affordable, accessible and has potential to prevent unnecessary hospitalization. During the COVID-19 pandemic, patients felt unsafe going to a hospital for a routine check-up [27]. 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 [27, 28]. Leveraging this technology in non-emergency cases where services do not require direct patient-provider interaction would be beneficial, especially given the low cost and technology infrastructure that it requires.

Conclusion

This study explored the differential IVR use by HF patients. Over a 12-week period, the results showed a positive outcome with 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. These findings suggest that IVR calls do have a positive impact on HF patients' management. The increased use of IVR in remote patient monitoring allows for a cheaper and more accessible form of at home recovery rather than a hospital stay. 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. Future strategies and policies should promote activity among older, female and community/rural patients. 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.

Acknowledgements We thank Dr. Hien Tran, Associate Professor at the Telfer School of Management, for her help and support in developing the analysis strategy used in this study.

Statements and Declarations The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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