

Using an interactive voice response system to improve patient safety following hospital discharge

Alan J. Forster MD FRCPC MSc^{1,3} and Carl van Walraven MD FRCPC MSc^{2,3,4}

¹Assistant Professor, ²Associate Professor, Department of Medicine, University of Ottawa, Ottawa, ON, Canada

³Scientist Ottawa Health Research Institute – Clinical Epidemiology Program, Ottawa, ON, Canada

⁴Scientist, Institute for Clinical Evaluative Sciences, Toronto, ON, Canada

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Correspondence

Dr Alan Forster
C406-1053 Carling Ave
Ottawa
ON K1Y 4E9
Canada
E-mail: aforster@ohri.ca

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Abstract

Background Patients often experience complications when transitioning from hospital to home. These complications are frequently related to poor monitoring. An interactive voice response system (IVRS) could improve post-discharge monitoring.

Objective To determine the feasibility and utility of an IVRS to monitor patients following hospital discharge.

Design Prospective cohort study at an academic health sciences centre.

Patients Consecutive internal medicine patients who had a touch-tone telephone, spoke English, had no cognitive impairments and were discharged home.

Measurements Feasibility was defined as the proportion of patients reached by the IVRS and the proportion completing an IVRS-based survey. Utility was defined as the percentage of patients whose outcomes could have been changed by the IVRS.

Methods We programmed the IVRS to call patients and administer a simple survey 48 hours after discharge. The survey's objective was to identify all patients with new health problems. Such patients were telephoned by a nurse to clarify and address the problem.

Results We enrolled 77 patients who were predominantly male (68%), elderly (median age 65 years) and chronically ill (median number of co-morbidities = 3). The IVRS reached 45 of the 77 patients (58.4%). Forty patients (51.9%) answered all questions on the survey. Twenty patients (26%, 95% CI 17%–37%) indicated new or worsening symptoms, problems with their medications, or requested to talk to the clinic nurse. For 10 patients (13%, 95% CI 7%–22%), the IVRS could have made a difference in their outcome.

Conclusion Using an IVRS, we were able to identify several important new health concerns arising following hospital discharge. Subtle changes could increase the feasibility and utility of IVRS technology in improving post-discharge outcomes.

Introduction

Patient care following discharge from hospital is problematic [1,2]. A common factor predisposing patients to post-discharge complications is a failure to monitor their conditions and treatments [1]. One method used to improve monitoring includes a hospital-based nurse or pharmacist systematically telephoning all patients to enquire about their status after they get home [3–5]. Dudas *et al.* suggest that a call to patients from a pharmacist within a week of discharge significantly reduces return visits to the emergency department [6].

Although a call-back programme seems promising, it is not perfect. First, it is costly to use highly skilled professionals to call patients, especially when such professionals are already in short supply. Furthermore, many factors make a call-back programme an inefficient use of their time. Patients will frequently not be at home when called and several attempts must be made to reach them [4–6]. Patients will occasionally wish to discuss matters that are not directly related to their health care. Most of the time patients will not be experiencing problems at the time of call [4]. If a call-back programme is to be implemented, a more efficient system would be beneficial.

Interactive voice response systems (IVRS) are information technologies that could be used to monitor post-discharge patients [7]. An IVRS allows people to interact with a database using a standard telephone. This allows the administration of surveys using IVRS-initiated telephone calls in which a pre-recorded dialogue prompts patients for responses. Patients answer by pressing the key pad of their telephone or through voice recognition software. In the context of providing post-discharge care, one could use the IVRS to screen patients for possible problems. For 'screen positive' patients, personal follow-up could result. Theoretically, the IVRS system could minimize the amount of time required by highly skilled professionals to contact and help patients.

Therefore, using an IVRS to identify which patients require more attention is theoretically appealing but its feasibility and utility is unknown in elderly patients who have been recently discharged from hospital. Although IVRS is ubiquitous in business, only a few studies have evaluated their impact in health care delivery [7–16]. The existing studies of IVRS show moderate improvements in preventive health care practices [10,13,16] or chronic disease management [8,9,11,12,15]. However, none of the studies use an IVRS for management of acutely ill medical patients. Furthermore, most of the studies require the patients to make inbound calls to the IVRS as opposed to receiving an outbound call [8,9,11–13,15]. Patients may not appreciate receiving an automated outbound call from an IVRS. In summary, although there are suggestions that an IVRS will facilitate care of post-discharge patients, there is a need for more research before recommendations to implement are made.

For these reasons, we designed this pilot study to measure the feasibility and utility of using an IVRS system to identify patients who require further attention after being discharged from hospital.

Methods

Setting and patients

This is a prospective cohort study at the Civic Campus of the Ottawa Hospital, a tertiary care hospital. As in all Canadian hospitals, the patients in the study had universal health care insurance that covers all hospital and doctor services.

Patients were potentially eligible for the study if they were admitted to either of the hospital's two 30-bed general internal medicine (GIM) services in October or November 2004. The GIM service cares for patients with multi-system or undifferentiated illness. While in hospital, patients are cared for by house staff who are supervised by board-certified internal medicine doctors. Working with each GIM service was a medical liaison nurse who facilitated the care of inpatients, including their transition home.

We excluded patients who did not speak English, who had cognitive impairments, who were discharged to someplace other than their own home and who had no touch-tone telephone. The study was approved by the Ottawa Hospital Research Ethics Board.

CallAssure

We used *CallAssure*, a US patent-pending IVRS solution designed to improve the care of patients following hospital discharge. *CallAssure* can be run on any modern personal computer (recom-

mended requirements: Pentium processor, 850 MHz CPU, 512 MB RAM), equipped with a telephony card with at least two analogue lines. In addition, *CallAssure* requires access to an email server (for notification messages) and, optionally, a printer (for reports).

Development of post-discharge survey

The objective of the post-discharge survey was to identify all patients who would require further attention from a nurse. If no potential problems were identified on the post-discharge survey, we reasoned that it would be very unlikely that a patient would require contact from a nurse. The call dialogue for the IVRS was carefully designed. First, we received input from our medical liaison nurse to determine the nature of calls they conduct with patients who are recently discharged from hospital. Using this information, we established an initial set of survey questions, which were forwarded to faculty members on the GIM service. Using their feedback, we then created an initial call dialogue. After hearing audiotapes of this call dialogue, we made some more minor adjustments to the wording of the questions.

In general, we kept the call dialogue as simple as possible. We asked three questions: Have you any new or worsening questions? Have you any problems that you think might be related to your medications? and, Would you like us to contact you? We limited the possible responses to the questions to 'Yes' or 'No'. We required users to input responses using touch-pads, as opposed to voice recognition, because we felt that this would be simpler to use, would be more intuitive for elderly patients, and would explicitly limit the answers possible by the patient.

Post-discharge survey administration

We started calling patients 2 days following hospital discharge. If no one answered the phone, the call was logged as 'incomplete'. If someone answered the phone, we identified whether it was the patient by asking 'Were you the patient discharged from the Ottawa Hospital on <discharge date>?' We used this generic prompt in order to meet international privacy regulations and to maintain the system's relative simplicity. If the person answered 'Yes' then the survey proceeded. If the person answered 'No', then the person was asked whether the system should call back. If the person responded 'Yes', then the call was logged as 'incomplete'. If the person responded 'No', then no further calls were made to the patient and the call was logged as 'unsuccessful'. If the call was picked up by an answering machine, then *CallAssure* would identify this. In this case, the system would hang-up and the call was logged as 'incomplete'.

We programmed *CallAssure* with the following parameters. We called patients between 9:00 AM and 8:00 PM. If a call was 'incomplete', then the system called back 3 hours later. The system called back every 3 hours until the call was completed, the person who answered the telephone responded that they did not wish a further follow-up call, or 48 hours had elapsed since the first call.

Study flow

The medical liaison nurse identified whether newly admitted patients were potentially eligible for the intervention. Patients

were then approached in order for us to describe the IVRS system, its intent and whether they wished to participate in the study. If they consented, then we spent 5 minutes teaching them about *CallAssure* and how they should answer the survey. Also, we entered their demographic data including their phone number into the study database. When the patient was discharged, we entered the discharge date.

On a daily basis, *CallAssure* queried the study database to determine newly discharged patients. For these patients, the following data were sent to *CallAssure*: the phone number, the medical team, the discharge date and a unique identifier. For the purposes of this pilot, we generated unique identifiers for patients to maintain privacy. Only the medical liaison nurse and study personnel had access to the key required to link this identifier to patient information.

Starting 2 days following discharge, *CallAssure* would initiate surveys. For patients responding 'Yes' to the screening questions, an email was sent to the medical liaison nurse. The medical liaison nurse then attempted to reach these patients to determine their reason for having a positive screen survey.

Analysis

We wished to determine the feasibility and utility of the IVRS. We defined *feasibility* as the proportion of discharged patients who successfully completed a telephone interview. To complete an interview successfully, the correct patient had to answer the phone and answer all of the questions by pressing the appropriate key pad of their telephone. We defined the *utility* of the IVRS as the proportion of patients in whom the IVRS could have made a difference in their outcome. For the system to make a difference, three conditions were required. First, the patient had to indicate that they had new or worsening symptoms, problems with their medication, or would like a call from the clinical liaison nurse. Second, the clinical nurse had to successfully contact the patient. Third, the clinical nurse had to intervene on the patient's care in some way. We reported these outcomes as rates. We used the Wilson score method to calculate 95% confidence limits [17].

Other outcomes for the study included: (1) the number of calls per patient; (2) the total number of calls made by the IVRS; and (3) the pattern of responses provided by the patients.

We evaluated which factors were associated with an increased probability of responding to the IVRS using Fisher exact test for categorical variables and Wilcoxon rank sum test for continuous variables. All analyses were performed using SAS v9.0.

Results

We enrolled 77 patients. Their characteristics are described in Table 1. Most of the patients were male (68%), were elderly (median age = 65 years) and had multiple medical problems (median – three chronic problems). The most common reason for admission was an acute infection, such as a urinary tract infection or pneumonia, occurring in 32% of admitted patients. Common chronic conditions were hypertension, coronary artery disease and type 2 diabetes mellitus. Most patients lived with a family member in their own home (70%) and reported having a family doctor (90%). The median length of stay was 5 days.

Table 1 Patient characteristics

Characteristics	Average
<i>n</i>	77
Age, median (IQR)	65 (49–78)
Male, <i>n</i> (%)	52 (68)
Reason for admission, <i>n</i> (%)	
Acute infection	24 (32)
Gastrointestinal disorder	9 (12)
Pulmonary disorder	7 (9)
Cardiac disorder	5 (7)
Fluid and electrolyte imbalance	5 (7)
No. of chronic conditions, median (IQR)	3 (1–4)
Chronic conditions, <i>n</i> (%)	
Hypertension	28 (36)
Coronary artery disease	22 (29)
Type 2 diabetes mellitus	14 (18)
Chronic obstructive lung disease	9 (12)
Prior stroke	6 (8)
Residence, <i>n</i> (%)	
Lives alone	22 (29)
Lives with family	53 (70)
Lives in retirement residence	1 (1)
Has a family doctor, <i>n</i> (%)	69 (90)
Length of stay, median (IQR)	5 (3–8)

IQR, inter-quartile range.

Of the 77 patients, we could not make any contact with 19 (25%, 95% CI 16%–35%) since no one answered the IVRS call. To these 19 patients, the IVRS made 11 IVRS call attempts per person (or 209 calls totals). In another 13 cases (17%, 95% CI 10%–27%), the person answering the call indicated that they were not the patient discharged and would not like the system to call back again. To these cases, the IVRS made 3.1 IVRS call attempts per patient (or 40 calls total). The remaining 45 patients (58%, 95% CI 47%–69%) responded to the IVRS call and indicated that they were the person discharged from hospital. These patients were contacted by the IVRS system after 2.7 calls per person (total of 108 IVRS call attempts). Thus, in total there are 357 IVRS call attempts made, or 4.7 per patient.

The characteristics of those patients who did and did not respond to the IVRS call were not dramatically different, although responders tended to be older, were in the hospital for a shorter stay and were less likely to have experienced an acute infection (Table 2).

Of the 45 patients responding to the IVRS, 43 answered at least one of the prompted questions and 40 answered all of the questions. Thus, the completion rate on the survey, defined as the proportion of patients contacted who answered all prompted questions, was 89% (95% CI 77%–95%). The feasibility of the IVRS, defined as the proportion of all patients who completed the IVRS survey, was 52% (95% CI 41%–63%).

Twenty patients (26%, 95% CI 17%–37%) responded positively to the survey for the following reasons: 10 indicated they were having new or worsening symptoms; 10 indicated they were having problems related to their medications; and 15 indicated they would like a call.

The medical liaison nurses attempted calls to these 20 patients. However, after multiple attempts only 14 could be contacted. In 10

Table 2 Characteristics of patients responding and not responding to the interactive voice response system

Characteristics	Responder	Non-responder	P-value
<i>n</i>	45	32	
Age, median (IQR)	69 (54–79)	61 (47–79)	0.3
Male, <i>n</i> (%)	30 (67)	22 (68)	0.8
Reason for admission, <i>n</i> (%)			
Acute infection	10 (22)	14 (47)	0.05
Gastrointestinal disorder	3 (7)	6 (19)	0.2
Pulmonary disorder	3 (7)	4 (13)	0.4
Cardiac disorder	5 (11)	0 (0)	0.07
Fluid and electrolyte imbalance	4 (9)	1 (3)	0.4
No. of chronic conditions, median (IQR)	3 (1–4)	3 (2–4)	0.6
Chronic conditions, <i>n</i> (%)			
Hypertension	15 (33)	13 (41)	0.6
Coronary artery disease	11 (24)	11 (34)	0.4
Type 2 diabetes mellitus	7 (16)	7 (21)	0.6
Chronic obstructive lung disease	6 (13)	3 (9)	0.7
Prior stroke	4 (9)	2 (6)	1
Residence, <i>n</i> (%)			0.3
Lives alone	11 (25)	11 (34)	
Lives with family	33 (75)	20 (63)	
Lives in retirement residence	0 (0)	1 (3)	
Has a family doctor, <i>n</i> (%)	39 (87)	30 (94)	0.2
Length of stay, median (IQR)	5 (2–7)	6 (3–12)	0.04

IQR, inter-quartile range.

of these patients, the individual had a potentially important problem that required an assessment or an intervention. Thus, the utility of the IVRS system – that is the proportion of patients in whom the IVRS could have made a difference in their outcome – was 13% (95% CI 10%–22%).

The types of problems encountered included relapses of the admitting problem ($n = 5$), problems obtaining or understanding medications ($n = 2$) and the development of new symptoms ($n = 3$) (Table 3). In all 10 of these cases, the medical liaison nurse assessed the situation and acted accordingly. For some patients, she simply ensured that there were adequate arrangements for the patient to be seen in follow-up. In other instances, she provided more active advice including, for example, changing prescriptions or advising the patient to come into the emergency department.

Discussion

With an IVRS to monitor patients following discharge from hospital, we were able to contact more than half of our cohort and the vast majority answered all the questions posed by the automated call. Of the patients contacted, approximately 40% indicated they were experiencing new or worsening symptoms, problems with medications, or that they would like to receive a call from a health provider. Thus, using our IVRS system, one in four medicine patients discharged were flagged as requiring personal attention from a clinical nurse, and half of these were ultimately felt to have benefited from nursing assessment or a change in therapy. Furthermore, our research highlights the efficiency of the system, as the system made 357 calls to triage patients while the clinical nurse needed to call only 20 patients.

Improving patient safety after discharge from hospital requires improved patient monitoring. Failing to do so leads to a significant

proportion of so-called ‘ameliorable adverse events’ or complications that should have been less severe if the health system responded appropriately [1]. Previous efforts to improve post-discharge care have not specifically targeted such monitoring. Such factors, including improved communication of hospital information with community providers [18] and increased continuity of care by hospital providers [19], have been associated with improved outcomes but lack intervention studies showing their success. Intervention studies involving discharge planning [20] have not found consistent benefits in terms of reducing post-discharge adverse outcomes. Interventions that aim to increase post-discharge monitoring of patients could have a greater effect on outcomes.

The IVRS system we tested was designed to facilitate this assessment. Automating the process has several benefits. It maximizes the number of patients that are contacted while minimizing the time required of highly trained professional. It also ensures an appropriate ‘audit trail’ so that the number and nature of problems that patients are experiencing after they go home can be tracked. This latter system can be used for ongoing quality improvement assessments.

The system was designed specifically to be as simple as possible. It purposefully asked disease non-specific questions. Although it is possible to make the survey patient or disease specific, a simpler design makes it easier to implement and appears to aid in user acceptance. A survey completion rate of close to 90% attests to this fact. Furthermore, we demonstrated that half the patients who said they were having a problem actually were having one when the nurse called. This speaks to the fact that the answers provided by patients were meaningful.

There are some limitations to our study. First, we did not systematically track the outcomes of all patients studied. Patients who

Table 3 Summary of the IVRS call outcome, the information obtained by the clinical nurse and the advice provided

No.	Description of index visit	IVRS response	RN information	RN advice
1	Elderly male with COPD exacerbation.	1. Medication problem 2. Request call back	Noted to have soft stools, which he suspected were due to antibiotics.	Judged that symptoms did not require intervention. Instructions to complete antibiotics and ensured follow-up.
2	Elderly female with prior stroke presenting with stroke-like symptoms.	1. New or worse symptoms 2. Medication problems 3. Request call back	Patient complained of a headache.	Informed the admitting hospitalist who did not feel that the symptoms were related to the admitting problem. Patient advised to follow-up with the family doctor.
3	Patient admitted with vertigo.	1. Request call back	Patient states doing very well.	No intervention required.
4	Patient with hyponatremia, secondary to hydrochlorothiazide.	1. New or worse symptoms 2. Medication problems 3. Request call back	Patient wanted to know why it was so hard for his family to talk to him while he was in hospital.	The RN re-assured the patient and no other intervention was required
5	Patient with endocarditis sent home on antibiotics.	1. Request call back	Patient was doing well on IV antibiotics.	No intervention required
6	Patient with pleural effusion secondary to metastatic lung cancer.	1. New or worse symptoms	Pain and dyspnoea were assessed.	There were no modifications in therapy required.
7	Patient with UTI.	1. New or worse symptoms	Patient was actually doing well.	No intervention required
8	Patient with arthralgias, and night sweats. Diagnosed with vasculitis and started on prednisone.	1. Medication problem 2. Request call back	Patient was slowly improving but uncertain whether she should continue the prednisone.	Instructions to continue medications until follow-up with rheumatologist.
9	Patient with pulmonary hypertension and peripheral oedema.	1. New or worse symptoms	RN identified that he was extremely weak.	She ensured that he had a follow-up with his community doctor.
10	Patient with severe anaemia underwent bone marrow biopsy. Biopsy results pending at discharge.	1. New or worse symptoms 2. Request call back	Patient extremely anxious.	Patient was advised that biopsy results were still pending and that there was a follow-up appointment with the hospitalist to review the results of the biopsy.
11	Patient admitted with UTI.	1. New or worse symptoms 2. Request call back	Patient experiencing extreme low back pain and is bed ridden	Patient advised to come see the hospitalist in urgent care clinic but stated she was too ill. RN arranged transport to emergency. Another call by RN 10 days later indicated improvement.
12	Patient with severe oedema secondary to pulmonary hypertension.	1. New or worse symptoms 2. Medication problems 3. Request call back	RN call identified that the patient had stopped taking his diuretics and his oedema was worsening again.	RN identified that the patient's primary care doctor was going to make a house call within 24 hours and would deal with the problem
13	Patient with a generalized rash diagnosed as an allergic drug reaction. Treated with benadryl	1. New or worse symptoms 2. Medication problems 3. Request call back	RN call identified that the allergic symptoms recurred but were not gotten worse.	Ensured patient had adequate follow-up with primary care provider
14	Patient admitted with orthostatic hypotension. Effectively treated with flornidol.	1. Medication problems 2. Request call back	RN identified that patient could not get prescription filled as pharmacist thought the instructions were unclear.	Prescription clarified and patient received medications.

COPD, chronic obstructive pulmonary disease; IVRS, interactive voice response system; RN, registered nurse; UTI, urinary tract infection.

did not respond to the system may have experienced a complication that we missed. Clearly, in order to understand the impact of the system, we need to know how many problems we miss using it. While important, this information was not captured in this evaluation as we simply wanted to get preliminary data on the feasibility and usability of the programme. An evaluation of all outcomes is significantly more expensive and would not be warranted if patients could not use the system. With our current understanding, we are able to plan future studies, which will specifically focus on this issue. Second, we only studied a relatively small patient group from a single institution. It is unclear whether other patient types, such as surgical, obstetrical or emergency department patients, would respond to the system in a similar manner. However, we feel that the patient group we studied had a number of challenges to interacting with technology, suggesting that use of the IVRS may be even better in other groups. A third problem is that we were unable to contact six of the 20 patients indicating a problem on the IVRS. This concerns us, and points to a limitation in the technology not our study design or methods. In future iterations of the IVRS, we will attempt to connect patients directly to a nurse by re-routing the IVRS call to a nurse-staffed tele-health programme, rather than emailing the clinical nurse.

In summary, we have demonstrated that it is possible to implement an IVRS solution to monitor patients post-discharge. Such a system is usable by patients and meaningful information is captured using it. Most importantly, a substantial proportion of IVRS reported problems require either a nurse assessment or intervention. This preliminary research suggests that it might be possible to significantly reduce post-hospital complications using an IVRS system. However, research addressing the limitations outlined above is required before making firm recommendations about its effectiveness.

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