Grant Final Report

Grant ID: R18HS17196

Virtual Patient Advocate to Reduce Ambulatory Adverse Drug Events

Inclusive project dates: 09/01/07 - 08/31/11

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Abstract

Purpose: After a hospitalization, approximately 1 out of 5 patients will suffer from an adverse event, one-third of which are preventable. Having a high quality discharge program followed by a pharmacist post-discharge call has been shown to significantly reduce rehospitalizations and adverse drug events. Our goal was to develop a post-hospital system to address this issue.

Scope: The "Post-hospital Louise" system educates on self-care and medication use, assesses patient understanding and adherence to medications and appointments, and monitors for adverse events in the days after discharge.

Methods: We developed and programmed the "Post-hospital Louise" system to be used by patients in the post-discharge period (specific aim 1 and 2). We pre-tested the system with 13 recently hospitalized patients, who came to our laboratory, and then made revisions to the system. Finally, we conducted a randomized controlled trial (specific aim 3). We then began ongoing discussions to disseminate the system (specific aim 4).

Results: Analysis of pre-testing system interactions and interviews showed that patients thought the system was useful and easy to use. An RCT with 52 subjects showed the system successfully educates on self-care and medication use; assesses, monitors and promotes patient understanding and adherence to medications and appointments; and monitors and reports adverse events (specific aim 3). Conclusions: The "Post-hospital Louise" system has great potential for being part of the health care system of the future..

Key Words: hospital discharge; health care transitions; health information technology

Final Report

Purpose

This report describes the work that was conducted to carry out the project entitled "Virtual Patient Advocate to Reduce Ambulatory Adverse Drug Events". The goal of the project reported here was to develop a post-hospital Virtual Patient Advocate (VPA) system, to provide an easy-to-use mechanism for a recently hospitalized patient to track his or her adherence to the discharge plan, report any adverse events (such as medication side effects) that have occurred post-discharge, and receive education and counseling regarding his or her health condition, medication regimen and followup appointments. The system is an extension of our "In-hospital Louise" system, to provide a familiar and accessible interface for patients.

The Specific Aims of this project were:

1. To program "Louise," our computer-based, interactive, animated character, to offer health education and advice to patients with limited health literacy on self-care and medication use through the transition from hospital to ambulatory care.

2. To design and implement an Ambulatory Care Plan using the VPA "Louise" to educate the patient and respond to questions.

3. To rigorously evaluate the health IT intervention in the ambulatory setting.

4. To build a robust dissemination program that by Year 3 will have introduced this system into a health care system that is a member of a national test bed.

Each of the Specific Aims is described in the methods and results sections below.

Scope

Background

The transition process from the hospital to the ambulatory setting is non-standardized and frequently poor in quality.[1] One in five hospital discharges is complicated by an adverse event within 30 days, often leading to an emergency department visit and/or rehospitalization.[2–4] Nationally, about 25 percent of hospitalized patients are readmitted within 90 days. Many readmissions stem from errors that can be directly attributed to the discontinuity and fragmentation of care at discharge.[5,6] High rates of low health literacy, lack of coordination in the 'hand-off' from the hospital to ambulatory care, gaps in social supports, and other limitations also contribute to the risk of rehospitalization, particularly among low-income urban patients.[7–9] Increasingly, as hospitalists provide more inpatient care,[10–20] it is difficult for primary care

physicians (PCPs) to be aware of all the complexities of a hospitalization.[21,22] Further compounding the problem, the typical 15-minute post-hospital followup visit does not allow the PCP adequate time to become familiar with the details of the hospitalization. Most such visits are added to already overbooked schedules at the time of discharge and frequently occur without access to a discharge summary. Thus, the transition from the hospital to the ambulatory setting is a 'hand-off' that opens the door to many potential medical errors.

Any attempt to reduce adverse events (AEs) will make care safer, reduce unnecessary rehospitalizations, and cut costs. A reduction in the rehospitalization rate, even by a few percentage points, would produce profound effects on the financing of health care.[23,24] Eliminating 4.7 percent of hospitalizations, a conservative estimate of the rate of unnecessary rehospitalizations, would save $5.1 billion annually.[25]

Overall, close to two-thirds of post-discharge AEs are preventable or ameliorable. With this study we were able to apply the lessons learned and the tools developed to the "other side of the transition"—the time between hospital discharge and ambulatory care (known as the time of patient self-care or the "black hole") and to the ambulatory visit itself. Factors related to ambulatory adverse drug events (ADEs) that were addressed in this project include: patient adherence, medication monitoring after discharge, protocols for high-risk drugs, patient-centered approach, patient activation, patient self-management skills, pharmacist involvement, and a focus on chronic conditions and health literacy.

This project builds on the work that we have completed in the course of two projects funded by the Agency for Healthcare Research and Quality (AHRQ): 1) *Re-Engineering the Hospital Discharge for Patient Safety* (Safe Practices Implementation Challenge Grant HS-014289-01), and 2) *Testing the Re-Engineered Hospital Discharge* (Partners in Patient Safety Grant HS 015905-02).

Through the process of our research activities, we designed what we now call the Re-Engineered Discharge (RED), a set of eleven discrete and mutually reinforcing components that we believe should consistently be part of every hospital discharge.[26,27] We built a computerized workstation that now electronically prepares the discharge plan for the patient. We also created a Virtual Patient Advocate (VPA), a character name "Louise," based on patient needs and preferences, who uses the discharge plan to prepare the patient for discharge and determines his or her degree of understanding of self-care, medications, ambulatory followup, and other aspects of the plan. In these past studies, the VPA conversed with patients only in-hospital at the point of discharge, on a kiosk wheeled into the patient's room.

The project described in this report was designed to adapt and test the VPA (In-hospital Louise) to address the problems of discontinuity and fragmentation of care that occur in the transition from the hospital to the ambulatory setting. The purpose of this project was to develop the technology and content to make it possible for the VPA to interact with patients after discharge from the hospital. This goal is consistent with the aim of RFA-HS-07-007, to improve the delivery, monitoring, and updating of patient-centered health information to ensure patients have the information they need to make better health care decisions. Specifically, this project addresses the following areas of interest and goals of the RFA: (1) shared decisionmaking, (2) patient-clinician communication, and (3) providing access to medical information.
This project also addressed (1) care coordination (cross-cutting), (2) self-management/health literacy (cross-cutting), and (3) medication management (preventing medication errors and overuse of antibiotics), three of the priority areas for transforming health care and health care

quality identified by the *Institute of Medicine* as described in the AHRQ report entitled *Priority Areas for National Action: Transforming Health Care Quality*:[28]

Evidence of Effectiveness of Use of VPAs during Transitions in Care. There are many reasons why a VPA should provide an effective medium for patients transitioning from the hospital to the ambulatory care setting, especially those from medically underserved settings such as Boston Medical Center (BMC). First, the human-computer interface relies only minimally on text comprehension and uses the universally understood format of face-to-face conversation. Second, VPAs can enhance recall of critical information. Third, the use of nonverbal conversational behaviors—such as hand gestures that convey specific information through pointing ("deictic" gestures) or through shape or motion ("iconic" and "metaphoric" gestures)[29]—provides redundant channels of information for conveying semantic content also communicated in speech. The use of multiple communication channels enhances the likelihood of message comprehension.[30] Finally, VPAs provide a much more flexible and effective communication medium than a video-taped lecture or even combined video segments. The use of synthetic speech makes it possible to tailor each utterance to the patient (e.g., using their name and other personal information), to the context of the conversation, such whether it is morning or evening.

Methods

Specific Aims 1 and 2: Technical Development of the "Post-hospital Louise" System

We designed a Web-based system for post-hospitalization to be used at home prior to an out-patient appointment. The development was based on our analysis of best practices of the clinical pharmacist, who conducted the post-discharge reinforcement call in our prior studies of hospital readmission using the ReEngineered Discharge (RED) protocols described in the background section. Significant time was spent in the development, testing, and refining of the Post-hospital Louise system, organized through weekly meetings of the development group and conducting the activities described below.

Patient-Pharmacist Conversations. To inform development of the computer interaction, three patients were recruited during their hospitalization and participated in audio-recorded one-on-one interviews with a clinical pharmacist. These sessions imitated what we hoped would be accomplished by the Post-hospital Louise system: a review of discharge medications and discussion of followup appointments and other medical issues.

Participants were asked to return to the hospital a few days after discharge, and meet one-on-one with a pharmacist to discuss how they were doing at home. If possible, participants scheduled a second followup visit with the pharmacist; two participants were able to do this. Participants were paid $25 for each visit. All conversations between the patients and pharmacist took place in a small hospital conference room, were audio-taped and were transcribed verbatim. We also conducted a separate interview with the pharmacist, to review the transcriptions from

the patient sessions, and discuss her motivation and rationale behind particular topics discussed with the patients.

We investigated the distinct techniques used by the pharmacist to detect any post-hospitalization issues that the patient might be experiencing. We used qualitative methods to analyze the conversation structure, issues detected by the pharmacist, patient questions, patient regimens, reported medication side effects and actions taken by the pharmacist. The information gathered from the patient-pharmacist interactions was used to inform design decisions for the Post-hospital Louise system. We adapted conversations that were used in the In-hospital Louise system that educated the patient about the prescribed medications, how to take them, what they are for and about common side effects to be aware of.

Figure 1. Examples of patient–pharmacist discussions used in development

Condition Review

Ok, so first can you tell me the main reason why you were in the hospital? *Ummm, I was having shortness of breath…and there was also, they found fluid on my lungs which might have been caused by a virus and it might have affected my heart*. Perfect, yep, right that's exactly the information that I got. Because of that virus around your heart, maybe your heart wasn't pumping as efficiently and your blood pressure was high, so they said that maybe you had some cardiomyopathy. That would be the diagnosis.

Medication Review

So how do you remember to take your medicines? Are pill boxes usually... *I just line 'em up. What I do is I put my diabetes medicine on one side, and then the others I just line 'em up and take them one-by-one*. OK, and that system seems to be working for you? *Yeah*. So whenever you're ready I'll have you just take one medicine at a time and we'll go through 'em. I'll compare it to the list I have here and I'll ask you a couple questions about each medicine. So, in any order that you want... *Fffffurosemide*….Yep Furosemide good. *I think this the fluid pill*. That is the fluid pill. *I take it in the morning*. OK and how many tablets do you take in the morning? *One*.

Side-Effect Discussion

Any side effects from this one? This is probably causing your headache, yeah. *It's not that bad it's like in the back here*. OK, how bad is the headache and how often does it come? *It's not too bad, it's tolerable, just annoying*. OK, so on a scale of say zero to ten, zero is no pain and ten is like the worst headache of your life, where would you put it? *Three*. You would put a three, ok and when you get the headache what do you usually do?

Appointment Discussion

Now when are your upcoming appointments? *I have one with the heart specialist on the 9th, and one with my primary care on the 20th*. Perfect so on the 9th you're going to see Dr. _____ the cardiology doctor at nine in the morning. Do you know where to go for that? *Yep*. Are you going to be able to make that appointment? *Yes*.

Script Reviews and Role Playing. Methods for identifying ADEs were evaluated through extensive script reviews and role playing. The review process also allowed scripts to be edited for tone. A timeline for patient interactions was set by the script-writing team to guide transitions from each content piece and to ease the programming process. At this time, mock-up screen images for the intervention were sent for programming. Additional diagnosis scripts, diagnosis pages, medications, medication scripts, primary care providers, and pharmacies were added to the selections available from the In-hospital Louise system.

Debugging the System. The study team tested the system and to identify areas that needed improvement. To facilitate the process and allow the team to make precise dialogue edits and flag errors to help “debug” the system, a program was written and incorporated into the test version of the system. When research team members identified an error or wanted to suggest an edit, they could click a button on the screen and a separate window would appear where they could describe the issue and then resume the conversation seamlessly. The programming team

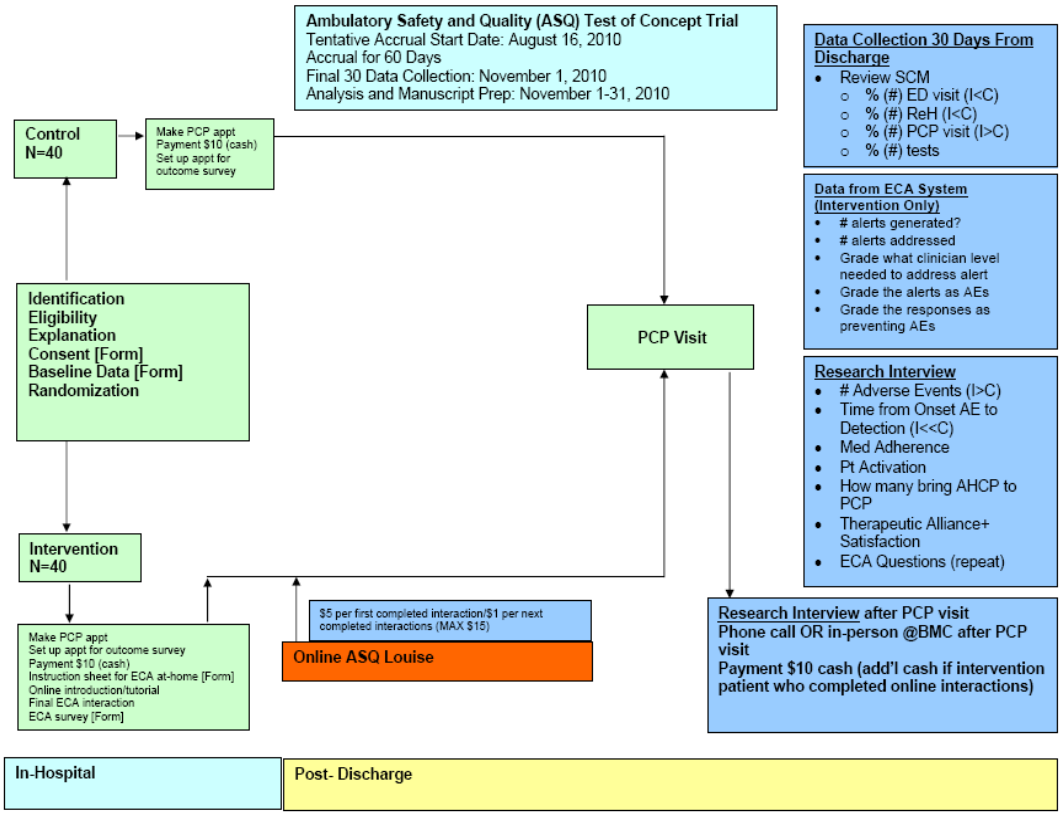
would receive the comments along with the exact "location" of the issue, simplifying and clarifying the "debugging" process.

Alerts. Testing was done performed to determine how the information from the Post-hospital Louise system flows from the patient to the clinical team and back to the patient and a codification system was designed on how to categorize these "alerts" and how to consistently respond to them.

Specific Aim 3: To Rigorously Evaluate the Health IT Intervention in the Ambulatory Setting

Specific Aim 3 has two components. In component 1 we pre-tested the system with 13 recently hospitalized patients. In component 2 we recruited 52 subjects into a randomized controlled study designed to test the design and functioning of the system and to collect data about the impact of the system (please refer to Figure 2).

Figure 2. RCT schematic



Component 1: Pre-Testing of the Post-hospital Louise System. After development of the initial Web-based system, we recruited 13 inpatients from BMC to test the system in our laboratory within two weeks of discharge. Each participant received $25 for completing the

session; during each session the participant would: (1) test the Post-hospital Louise system, while a member of the Web-development team observed the interaction and took notes; and (2) participate in a one-on-one, audio-recorded interview with the same researcher, to discuss his or her reactions to the system. The interviews were transcribed verbatim and reviewed by the research team to identify key suggestions to improve the system in preparation for the RCT.

Component 2: Conduct a Randomized Controlled Trial. We then conducted a two-armed RCT using the Post-hospital Louise system to conduct the post-hospitalization reinforcement component of Project RED. The hypothesis was that the use of the innovative VPA technology would reduce ADEs related to the transition from the hospital to the ambulatory environment.

All patients admitted to the inpatient general medical services at Boston Medical Center (BMC) were evaluated for study enrollment. Each morning the research assistant, using a census printed from the BMC centralized registration system at 7:00 a.m. each weekday, identified all patients admitted to the general medical service in the last 24 hours. He or she then approached patients to explain: (1) the purpose of the study; (2) possible randomization to a control group; and (3) IRB safeguards. If a patient was interested in participating, the research assistant obtained informed consent. All details of the consent form were verbally communicated as part of the consent process, and patients were given a copy of the signed consent form. After consent, the research assistant determined whether the participant was in the intervention or control group, using sealed envelopes prepared by the statistician prior to study start-up. After randomization, the research team carried out the methods for each of the two groups.

Inclusion criteria included patients who: (1) were at least 18 years old; (2) were admitted with Primary Care in the system (a PCP here at BMC in Family Medicine, Internal Medicine, or Geriatrics) OR if admitted with no primary care provider, patient is willing to be assigned a PCP from BMC; (3) were able to communicate in English with health providers; (4) reported access to a computer and broadband Internet and were willing to use this computer to access personal health information; (5) were taking at least three prescription medications at baseline (self-report at time of enrollment); (6) reported access to a telephone and could provide telephone number; (7) reported having an active email address OR was willing to let the research team set up an email address; (8) were physically able to use a computer (see computer screen, hear computer sound, and use hand to move computer mouse).

The two study groups were: (1) control group, which received the BMC standard of care and procedure for discharge and an ambulatory appointment was scheduled within two weeks of discharge; and (2) an intervention group, which received the elements of a comprehensive discharge as determined by our previously studied "Re-engineered Discharge" that includes: (a) a Comprehensive Patient Centered Discharge Plan; (b) a written discharge portfolio, called the “After Hospital Care Plan” (AHCP); (c) Delivery of the AHCP to the primary care physician; (d) an ambulatory care appointment scheduled within two weeks after discharge; and (e) the Post-hospital Louise interactions on home computer throughout the time from discharge to first ambulatory visit. The interactions included educational and self-management support from the VPA, which promoted patient activation prior to the first ambulatory visit.

The primary outcome variable in the study was number of adverse drug events (ADEs) until first ambulatory visit. We also reviewed BMC's administrative database to identify any rehospitalizations or emergency department visits within 30 days of discharge. We recorded the date of these hospital services for use in statistical survival analyses and the length of stay of the index hospitalization and of any rehospitalizations.

After the subject's first ambulatory visit following the index discharge, the research assistant called the subject and conducted the outcome patient survey. Using a script, the subject was asked about: (1) number, approximate dates, and site of all hospitalizations; (2) number of ambulatory visits, included a PCP and any specialty providers; (3) number, approximate dates, and site of emergency department or urgent care visits; (4) satisfaction with system; (5) self-perceived readiness for discharge; and (6) Forster symptoms.

To determine adverse drug events (ADEs), we used the method developed and refined by Forster which was adapted to include events occurring up to the first ambulatory visit. Specifically, information from the discharge summaries and the outcome patient survey of all study subjects were abstracted into a format that blinds outcomes-assessors from the study group. For each symptom that the subject reported at the outcome patient survey, the research assistant asked the subject to describe the timing of the symptom's onset, the effect of the symptom on physical functioning, and what the subject did to relieve or investigate the symptom. For any subjects with subsequent hospital utilization since the index hospitalization, we collected the relevant medical records (ED progress notes and hospital history and physicals). For subjects with subsequent hospital utilization at other institutions, we relied on patient accounts. We then combined the discharge summary, information from the telephone interviews, and any subsequent hospital utilization information into an event summary.

Two physicians, who were blinded to study group, then reviewed this information to identify ADEs. The steps in the outcomes-assessment process were as follows: (1) two physicians independently analyzed each event summary for ADEs using implicit criteria; (2) these outcomes-assessors rated on an ordinal scale from 1-6 their confidence that medical management caused an injury (injuries rated 5 or 6 are considered ADEs); (3) outcomes-assessors then rated each AE for ameliorability and preventability; and (4) when there was disagreement between the two outcomes-assessors, they discussed the event to try to reach an agreement, and a third assessor was used to resolve events without consensus. Preventable ADEs are those that are due to medical error (i.e. they could have been avoided). Ameliorable ADEs are those that are not preventable, but whose impact could have been reduced if the care had been provided differently. Finally, the outcomes-assessors categorized the type of each ADE as: adverse drug event, procedure-related injury, nosocomial infection, fall, therapeutic error, diagnostic error, or other.

The participants recruited for the RCT received compensation. All participants received $10 upon enrollment. Intervention participants were paid $5 for the first completed Post-hospital Louise computer interaction and $1 for each additional time that they completed an interaction with the system, with a limit of $15 for interaction incentives. They received this incentive up until their first scheduled ambulatory appointment via mail.

Specific Aim 4: Build a Robust Dissemination Program

Refer to Results below for discussion of this specific aim.

Results

Specific Aims 1 and 2: Design of the Post-hospital Louise

Study of Pharmacist Conversational Structure. The conversations between the patient and pharmacist followed a structured plan, and were generally pharmacist-driven. Prior to the first conversation, the pharmacist reviewed the patient's hospital discharge summary to familiarize herself with the patient's case and discharge instructions. Upon meeting the patient, the conversation began with an introduction and quickly moved to a discussion about the patient's hospitalization and medical condition. In this portion of the conversation, the pharmacist sought to ascertain the patient's point of view on what led to the hospitalization, as well as to find out if the patient knew his or her discharge diagnosis. She also asked if the patient had returned to the hospital, emergency department or to any clinical appointments since leaving the hospital, in order to determine whether the prescribed medications had been changed since discharge, so that they could be accurately reviewed later on in the conversation.

When patients returned for a second conversation with the pharmacist (two of three subjects), these followup conversations followed a similar structure to the initial interaction, but with the amount of time spent on each topic allocated differently. For both patients, the pharmacist spent 13 percent of the second conversation explicitly following up on issues that were discovered during the previous session. For Patient 3, who was not able to bring her medications to the first session, but did bring them to the second session, the pharmacist followed almost the same structure the second time around, spending 54 percent of the time reviewing medications and eight percent of the time on education regarding the patient's medical condition. For Patient 2, the pharmacist altered her approach during the second session, changing the time spent discussing medications from 52 percent to 25 percent and increasing the amount of time spent on medical condition education from seven percent to 26 percent.

During the course of the conversation, the pharmacist also discussed topics that were unique to each patient. For example, one patient had recently lost his health insurance and had trouble filling his prescriptions. The pharmacist listened to the patient's background on the situation and made any necessary arrangements to ensure the patient was receiving all available assistance.

Medications and Side Effects. After reviewing the patient's medical condition, the conversation moved to a discussion about the patient's medications. Patients were asked to bring in all of their prescription medications to each session and the pharmacist had them place these medications on a table between them at the start of the session. The pharmacist began by asking the patient about the method he or she used for remembering to take their medicines and, specifically, whether or not he or she used a pill box. Next, each medication was reviewed one by one, with the patient choosing the order in which the medications were discussed. For each prescription, the pharmacist had the patient read the name of the medication aloud; describe how often he or she took the medication each day, and how much he or she took at one time. The pharmacist reconciled the patient's information with the information listed on the patient's discharge summary and clarified and corrected any misunderstandings by the patient. This portion of the conversation was typically the longest, taking up 55 percent of the conversation, on average.

When reviewing medications, the pharmacist would often ask about side effects. If a patient reported or endorsed a side effect, the pharmacist would find out when it started happening, how severe the patient thought it was, how often it was occurring and whether or not the patient had taken any action to deal with the side effect. She would then give advice to the patient on how the side-effect could be handled or avoided, and what action the patient should take if it worsens.

For 57 percent of all medications, the pharmacist specifically asked about possible side effects. Each patient endorsed at least one side effect during the conversations. Of the five total side effects detected, one was detected by the patient self-reporting the issue after the open-ended question, “Do you think you are having any side effects from this medication?” another was detected by a closed-ended question ("Any dizziness?") and the remaining three side effects were detected by mentioning that a specific side effect is possible and then asking if the patient had experienced it, such as, “Sometimes when people start taking this they feel tired, are you feeling tired?” The pharmacist’s choice for framing and asking about side effects seemed to vary by patient. For example, Patient 2 was the only one of the three participants who could not explain why his medications were prescribed to him. Thus, the pharmacist altered her approach; with Patient 2 she always used the technique of asking the open-ended question, “Are you having any side effects?” If the patient did not volunteer any side effects, the pharmacist followed by mentioning and teaching about a specific side effect that can occur with the medication and then asking if the patient had experienced that specific side effect.

Any time a patient reported a side effect, the pharmacist would find out how often it was occurring and how bad the patient thought it was, in order to help inform her recommended course of action. For all of the side effects that the patients endorsed, the pharmacist encouraged monitoring and followup within a few days. For some, she also recommended a specific course of action, such as an over-the-counter remedy (for the headache) or switching the medication from morning to the evening (for drowsiness).

When interviewing the pharmacist about the patient sessions, we were particularly interested in the 43 percent of medications for which she did not ask about any side effects. It was often the case that these were over-the-counter (OTC) medicines rather than prescription medicines. If a side effect for an OTC medicine was potentially serious, such as bleeding with aspirin, the pharmacist did mention it to the patient, but most often side effects were not mentioned for OTC medicines. In other instances, the pharmacist often grouped medications together by indication, and if for example, the patient was on several medications for blood pressure, and dizziness was the most common or serious side effect for all of those medications, the pharmacist would ask about it one time, for one of the medicines, and not bring it up for the rest.

If the pharmacist did bring up the topic of side effects, she almost always mentioned only one of the several potential side effects for that medication. As most conversations were over an hour long, the pharmacist explained her decision to keep things as brief as possible and prioritize the most important side effects for discussion. For side effects, we concluded that the onus was on the patient to say, “I think this [side effect] is going on, and I think it might be attributed to a medication. Do you agree?” If they didn’t bring anything up, then the pharmacist would go through the possible side effects that are life-threatening and that would send them back to the ED, or would indicate that the patient should stop the medication.

Issues Detected by the Pharmacist. During each session, the pharmacist detected an average of 3.4 problems for each subject. These included patients who had misunderstood how often they were supposed to take their medications, had experiences with medication side effects,

were confused about dates/times of followup appointments, and demonstrated a lack of disease self-management. With our goal of building a post-discharge system for the detection and monitoring of ADEs, we were particularly interested in how the pharmacist uncovered these issues, how she attempted to resolve them, and if the patient was compliant in following the pharmacist's recommendations. In this section, we discuss the different classes of problems detected and the various courses of action taken by the pharmacist.

The most common problem detected by the pharmacist was the patient taking his or her medicine differently than prescribed. This issue is deeply complex, and cannot be attributed to one simple cause. Previous work has shown that a wide variety of factors can influence medication adherence, in our observations of the patient-pharmacist conversations, three examples of non-adherence emerged.

First, the patient had his or her prescribed medicine at home, was taking the medicine, but was not taking it according to the physician's orders. For Patient 1, this seemed to be a case of non-intentional non-adherence: the patient simply misunderstood how often to take three of his medicines. In this case, the pharmacist corrected the patient and checked for patient understanding by having the patient repeat back the correct times of day for the medications that were not being taken correctly. At the end of the conversation, the pharmacist reviewed the correct times to take each medicine, to reiterate the prescribed plan.

Patient 2 had a similar situation, with a medication prescribed for twice per day, but the patient was only taking it once per day. However, in this instance, the *patient* was correct, and the *discharge summary* was incorrect. The particular medication was for diabetes, and prescribed according to the patient's blood sugar levels. When leaving the hospital, the patient was told to take the medicine once per day, and was following that order. The information in the discharge summary listed the medication as twice per day, and was either entered incorrectly or never updated to reflect the most recent information. After discussing the patient's blood sugar levels with the patient, the pharmacist realized that the error was most likely on the side of the hospital's entry, not on the side of the patient. The pharmacist recommended continuing to take the medicine once per day, called the patient's primary care office and had an appointment made.

When the patient returned for the second session, the pharmacist asked the patient to review what the primary care physician recommended, and discovered that indeed the medication should only be taken once per day.

In the last example of non-adherence, the patient did not have the prescribed medication, and thus was not taking the medication. This included new prescriptions made during the recent hospitalization, as well as standing prescriptions that were never refilled. Patient 3 was not able to bring in her medications during the first session with the pharmacist, but the pharmacist still went through each medication on the discharge summary one-by-one to determine if the patient recognized the medication by name, and whether or not the patient was taking it as prescribed. During that conversation, the patient stated that she never received the paper prescriptions for two of the medications prescribed during hospitalization and that she had not refilled a previously prescribed medication for over a year. The pharmacist discovered early in the conversation that the patient had a followup appointment with a nurse practitioner that same afternoon, so she gave the patient a detailed printout listing medications for which the patient needed new prescriptions, for the patient to bring with to her appointment. During the second session with the pharmacist, Patient 3 was able to bring in her medications and the pharmacist and patient were able to review them together more thoroughly than during the previous session. During this followup conversation, the pharmacist discovered that for one of the medications that

the patient thought she didn't have, she in fact did have it and was taking it as prescribed. For the other two medications, she had still not picked them up from the pharmacy and was not yet taking them. In addition, a few days earlier, this patient had been re-hospitalized for breathing problems, and upon discharge was prescribed a steroid to begin taking immediately. Unfortunately, the patient had not yet filled this prescription**.**

Table 1. Patient–pharmacist conversation details

	Conversation Length	Percent of talking done by the patient	Number of medications discussed	Number of issues discovered	Number of questions the patient asked
Patient 1: First conversation	74 minutes	49%	11	5	10
Patient 2: First conversation	68 minutes	41%	11	4	0
Patient 2: Second conversation	66 minutes	47%	11	2	0
Patient 3: First conversation	58 minutes	49%	15	4	0
Patient 3: Second conversation	29 minutes	50%	16	2	0

Ambulatory Appointments. Following the medication discussion, the pharmacist would review the patient's post-hospitalization ambulatory appointments, including primary care and specialist appointments, if necessary. During this portion of conversations, the pharmacist discovered if the patient understood when and where every appointment was going to take place, who the appointment was with, what it was for, and whether or not the patient was still able to go to the appointment. The pharmacist also discussed emergency situations with the patient, and counseled the patient on situations when they should go to the Emergency Department, and situations when it would be better to contact their primary care physician's office or pharmacy.

Patient Self-Care Regimens. Finally, the pharmacist discussed condition self-management with patients. For two of the patients, diabetes self-management was reviewed in detail, discussing how often they should check their blood sugar levels, what their goal level should be, medical terminology related to diabetes, signs of hypoglycemia and explaining what do in an emergency. For another patient, blood pressure was reviewed in detail, including recent lab test results and goals for the patient.

The pharmacist found two problems regarding self-care and management of the health condition. In one instance a participant was instructed to weigh himself daily in order to monitor the effects of his blood pressure medication; however the patient did not own a scale. In this situation, the pharmacist called the doctor's office, on behalf of the patient, to see if they would be able to give him a scale prior to his appointment.

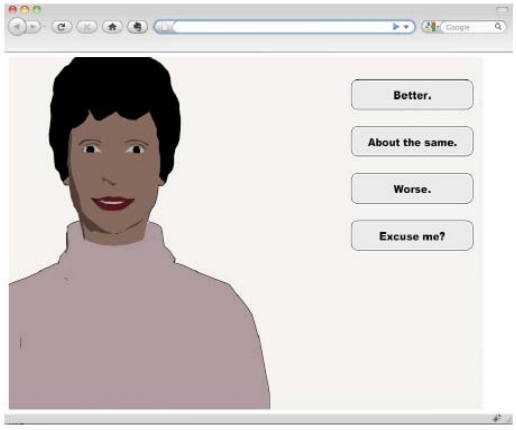
In her first conversation with another participant, the pharmacist discovered that the patient was not monitoring her blood glucose levels. This patient didn't want to experience the pain of pricking herself, had an aversion to needles, and didn't want to be thought of as a "junkie." The pharmacist reviewed the importance of self-monitoring with the patient, educated about her glucose goals, and, most importantly for this patient, taught her how to recognize signs of hypoglycemia and what to do in an emergency. The pharmacist encouraged the patient to try to check her blood sugar once per day.

Patient Questions. Of the three patients in our study, only one asked the pharmacist questions during the session. This patient asked several questions throughout the conversation,

mostly to clarify previous instructions from the pharmacist or to ask additional for information from the pharmacist (e.g., clarifying generic vs. brand-name of a medication, side effects for a given medication, or whether a medication should be taken with food). A summary of the patient–pharmacist conversation studies is shown above.

Post-hospital Louise System Design. In this section, we discuss the design decisions for the Post-hospital Louise system, in Figure 3 below, based on the information gathered from the patient-pharmacist interactions that are described above.

Figure 3. Post-hospital Louise asking subjects how they feel since leaving the hospital



Teach Back. One conversational technique that was incorporated in the system is the teach-back method for testing patient understanding.[31,32] This method involves having the patient "teach" providers about their health information, and provides an excellent way to determine whether or not the patient understands the information given by their provider. In our study, the clinical pharmacist used this technique to test comprehension almost exclusively, especially when discussing the patient's medication regimen. Instead of asking, "Are you taking this medication twice a day, one pill each time?" making it easy for the patient to simply say "Yes," the pharmacist asked the patient to tell her when and how much he or she was taking. This allowed for an increased assessment of the patient's understanding, and also a provided a higher likelihood of detecting a problem, if one existed.

Side Effect Discussion. Having an automated system determine which side effect to discuss is a challenging problem. On the one hand, the system should be as accurate as possible: one approach would be to list and discuss all possible side effects for each medication. On the other hand, the system should also be as relevant as possible, and not discuss superfluous information with the patient. This can avoid making the conversation long or irrelevant, and that users become disinterested and stop using it all together.

In our design approach, we seek to strike a balance between providing accurate and relevant information, while reducing the chances of overwhelming the patients (refer to Figure 4). For each medication in our database, we had clinicians enumerate the top-five side effects for the system to discuss. The side effects are the most common or the most likely to be life threatening.

Figure 4. Algorithm for post-hospital Louise side effects discussion

1. For each medication M_i load the associated side effects into a list SE_i
2. Display the 20-item adverse event checklist to the patient and collect responses
   a. For each item f from the checklist that was not endorsed by the patient
      i. For each medication's side effect list SE_i check to see if f is a member and if so, remove it from SE_i
   b. For each item f that was endorsed by the patient, do full side effect assessment
3. For each medication M_i that the patient has acquired and is taking, present the list SE_i to the patient and collect responses
   a. For each side effect j in SE_i that was not endorsed by the patient
      i. For each medication side effect list $SE_{(i+1) \ldots n}$ check to see if j is a member and if so, remove it from SE
   b. For each side effect j that was endorsed, do full side effect assessment

Prior to discussing medications with the patient, the Post-hospital Louise displays 20 common ADEs, adapted from Forster, in a checklist format, which allows patients to report if they have experienced any of those events since leaving the hospital. This information allows the Post-hospital Louise to reduce the number of side effects mentioned for each medication. For example, if the patient denies that he or she has experienced any headaches during the initial Forster checklist, and the patient is taking a medication with headaches as a potential side effect, then the Post-hospital Louise will not need to ask about that side effect when reviewing those medications. Likewise, as the system discusses each medication and we acquire more knowledge about side effects that the patient is or is not experiencing, this will influence the side effects we need to discuss with different medications later in the conversation. We have also incorporated a mechanism for the patient to self-report any other side effect, whether it is tied to a medication in our database or not. This allows us to keep the side effect conversation short and relevant, while also maintaining expressivity by the patient.

Ongoing Interactions. The system was designed for daily interactions to transition patients smoothly from their hospitalization to their first ambulatory appointment after discharge, with its content continuously adapted based on prior interactions with the patient and the actions of clinicians monitoring the system. In designing the conversational structure for repeated interactions with the Post-hospital Louise, we followed the approach of the clinical pharmacist to keep the interactions short, and focus heavily on issues that need to be followed-up. We also designed the system to allow flexibility for the patient to be able to ask questions and find out more information if they so desire.

The Alert System. In order for the system to effectively discuss followup issues with patients, we designed a back-end alert management system whereby an alert is generated that notifies a project team member clinician of issues detected by the Post-hospital Louise. It is

important for a medical expert to review the issues that the Post-hospital Louise uncovered, work to resolve them (e.g., calling the patient's physician to clarify any misunderstanding about medication dosage), and provide feedback to the patient on the status of that issue. We designed the Post-hospital Louise to be aware of the resolution of issues, along with the ability to discuss the resolution and recommended course of action with the patient.

The Ambulatory Care Plan. Patients are given the option of printing an Ambulatory Care Plan (based on the Project RED "After Hospital Care Plan," which is given at hospital discharge) that is electronically prepared. If the patient chooses, this health plan can be brought to an ambulatory appointment and used as a focus of discussion. The patient can choose at any time to have the VPA assess his or her understanding of the medication regimen and appointments and to produce a report of key aspects of the care plan not understood by the patient.

Specific Aim 3: RCT Testing the Post-hospital Louise System

The Context and Settings of this Work. The study population was drawn from patients of BMC and the 15 health centers comprising BMC-affiliate Boston HealthNet, a network of community health centers located in Boston's most impoverished neighborhoods. Patients were enrolled from patients on adult medicine inpatient units.

As the largest safety net provider in New England, Boston Medical Center (BMC) serves primarily the low-income, uninsured and underinsured residents of Boston, regardless of ability to pay and is considered a safety net hospital caring for vulnerable populations as defined in the RFA.[33] Seventy percent of BMC patients are racial and ethnic minorities. Many patients at BMC are newly arrived immigrants, refugees, and other first generation Americans from Africa, Eastern Europe, Central and South America, Asia, and the Middle East. More than 30 percent require interpreter services, which are available in more than 60 languages. More than half (54 percent) scored at the eighth grade level or below on a measure of health literacy, the Rapid Estimate of Adult Literacy in Medicine (REALM).[34] More than half have incomes at or below $19,600 per year. The majority of patients are Medicaid recipients (27 percent), Medicare recipients (26 percent) or self-pay/free care pool patients (23 percent); less than one fourth (23 percent) have commercial insurance. Blacks are over-represented in the BMC patient population, accounting for 44 percent of outpatient visits and 39 percent of inpatient admissions to BMC, compared to only 25 percent of the population of Boston.[35]

BMC patients exhibit high rates of morbidity and mortality from AHRQ's priority conditions—particularly asthma, diabetes mellitus, hypertension, stroke, cancer and ischemic heart disease. The human and economic costs of preventable hospitalizations and rehospitalizations among urban safety net patient populations are enormous. In addition to serving low-income and minority residents of Boston, BMC serves a range of special populations, including people living with HIV/AIDS, pregnant HIV+ women, survivors of torture, the homeless, high risk obstetrical patients, children affected by HIV, children with failure-to-thrive, children and adolescents at risk of obesity, people with mental illness, substance abusers, and dually diagnosed individuals.

Table 2. Baseline subject characteristics for RCT

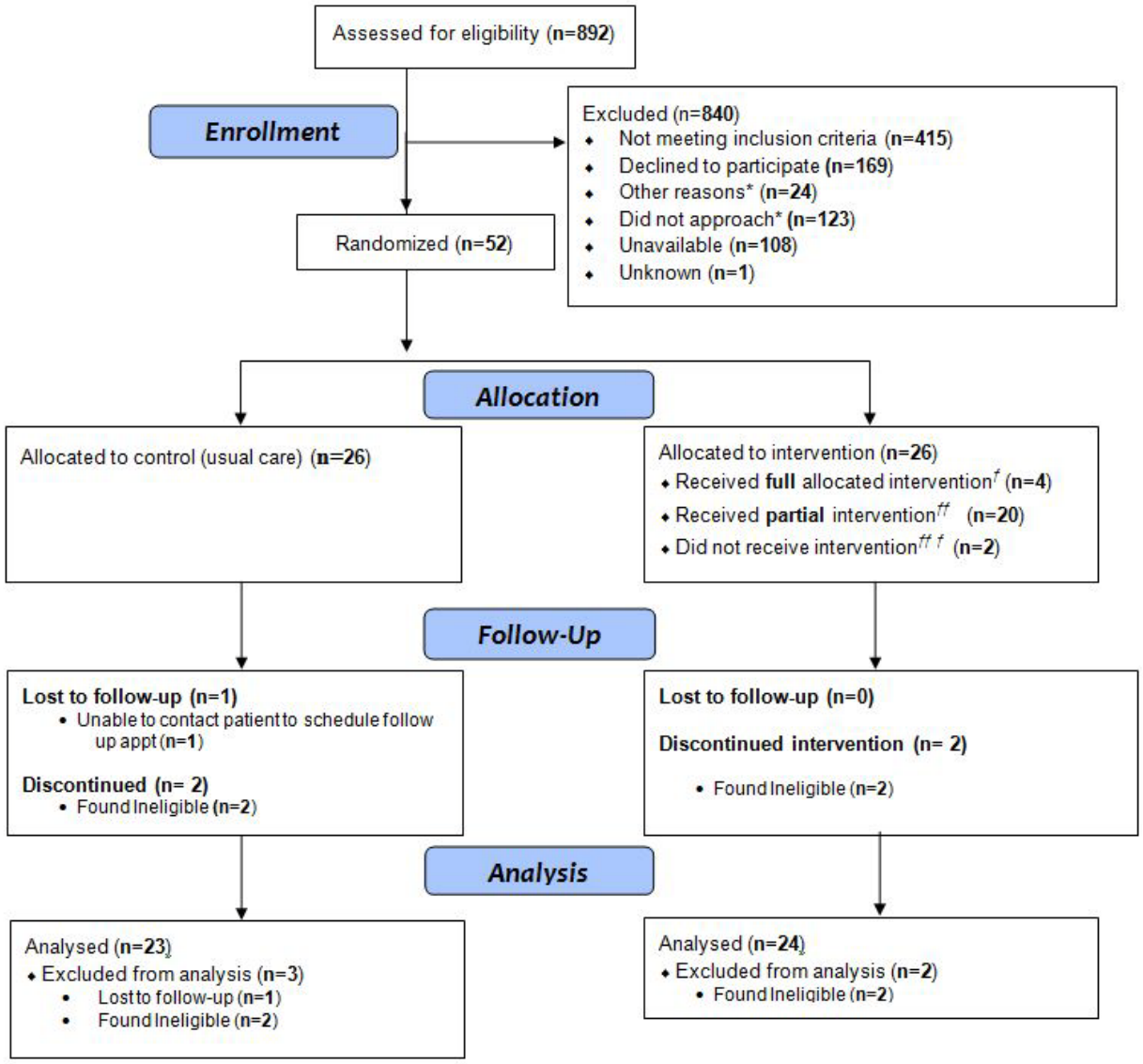
	Randomization: Control (%) N=23	Randomization: Intervention (%) N=24	Total
Age: 18-29	4 (50.00)	4 (50.00)	8
Age: 30-39	4 (57.14)	3 (42.86)	7
Age: 40-49	3 (30.00)	7 (70.00)	10
Age: 50-59	7 (50.00)	7 (50.00)	14
Age: 60-69	4 (66.67)	2 (33.33)	6
Age: 70+	1 (50.00)	1 (50.00)	2
Gender: F	12 (41.38)	17 (58.62)	29
Gender: M	11 (61.11)	7 (38.89)	18
Marital Status: Single	14 (51.85)	13 (48.15)	27
Marital Status: Divorced/Widowed/Separated	4 (36.36)	7 (63.64)	11
Marital Status: Married	5 (55.56)	4 (44.44)	9
Income: Unknown	8 (53.33)	7 (46.67)	15
Income: None-$19,999	10 (55.56)	8 (44.44)	18
Income: $20,000-$39,999	5 (50.00)	5 (50.00)	10
Income: $40,000-$74,999	0 (0.00)	2 (100.00)	2
Income: $75,000 or more	0 (0.00)	2 (100.00)	2
Education: Incomplete High School	7 (58.33)	5 (41.67)	12
Education: High School or Equivalent	9 (75.00)	3 (25.00)	12
Education: Incomplete College	5 (31.25)	11 (68.75)	16
Education: College Degree	2 (28.57)	5 (71.43)	7
Insurance: Free Care	1 (100.00)	0 (0.00)	1
Insurance: Medicaid	14 (50.00)	14 (50.00)	28
Insurance: Medicare	2 (22.22)	7 (77.78)	9
Insurance: Other/unknown	2 (66.67)	1 (33.33)	3
Insurance: Private	4 (66.67)	2 (33.33)	6
Employment: Disabled/Injured	10 (43.48)	13 (56.52)	23
Employment: Part Time	2 (50.00)	2 (50.00)	4
Employment: Retired	5 (83.33)	1 (16.67)	6
Employment: Student	1 (50.00)	1 (50.00)	2
Employment: Unemployed	3 (50.00)	3 (50.00)	6
Employment: Full Time:	2 (33.33)	4 (66.67)	6
Race: Black	14 (45.16)	17 (54.84)	31
Race: Native Hawaiian /Pacific Islander	2 (100.00)	0 (0.00)	2
Race: Other	3 (50.00)	3 (50.00)	6
Race: White	4 (50.00)	4 (50.00)	8
Born USA: N	5 (62.50)	3 (37.50)	8
Born USA: Y	18 (46.15)	21 (53.85)	39
Computer Access: friend/ family computer	4 (80.00)	1 (20.00)	5
Computer Access: home	15 (46.88)	17 (53.13)	32
Computer Access: library	4 (66.67)	2 (33.33)	6
Computer Access: other	0 (0.00)	1 (100.00)	1
Computer Access: work	0 (0.00)	3 (100.00)	3
Computer Experience: Never used	1 (100.00)	0 (0.00)	1
Computer Experience: Tried a few times	8 (61.15)	5 (38.46)	13
Computer Experience: Use regularly	14 (50.00)	14 (50.00)	28
Computer Experience: Expert	0 (0.00)	5 (100.00)	5
Feel about Computers: Don't like them	1 (100.00)	0 (0.00)	1
Feel about Computers: They're OK	9 (47.37)	10 (52.63)	19
Feel about Computers: Love using them	13 (48.15)	14 (51.85)	27
Primary Language: English	22 (48.89)	23 (51.11)	45
Primary Language: Other	1 (50.00)	1 (50.00)	2
Been Homeless: N	19 (46.34)	22 (53.66)	41
Been Homeless: Y	4 (66.67)	2 (33.33)	6

Table 2. Baseline subject characteristics for RCT (continued)

	Randomization: Control (%) N=23	Randomization: Intervention (%) N=24	Total
Has PCP: N	4 (66.67)	2 (33.33)	6
Has PCP: Y	19 (46.34)	22 (53.66)	41
Depression Status: Depressed	4 (33.33)	8 (66.67)	12
Depression Status: Not Depressed	19 (54.29)	16 (45.71)	35
Frequent Flier: Yes	15 (51.72)	14 (48.28)	29
Frequent Flier: No	8 (44.44)	10 (55.56)	18
REALM: 0-44	2 (100.00)	0 (0.00)	2
REALM: 45-60	2 (28.57)	5 (71.43)	7
REALM: 60-66	15 (45.45)	18 (54.55)	33
REALM: Total	19	23	42
Illegal Drug: N	16 (44.44)	20 (55.56)	36
Illegal Drug: Y	7 (63.64)	4 (36.36)	11
Alcohol Use: N	19 (48.72)	20 (51.28)	39
Alcohol Use: Y	4 (50.00)	4 (50.00)	8

Enrollment. As shown in Figure 5, 892 potential subjects were assessed for eligibility and 52 were enrolled. The remaining 840 were excluded for the following reasons: not meeting inclusion criteria (n=415), declined to participate (n=169), were not approached or were unavailable (n=231) or other reasons (n=24) (e.g., reaching the maximum subjects for the day or previous enrollment in a RED trial).

Figure 5. RCT CONSORT flow diagram



* did not enroll - not staffed or following subjects from previous days, reached maximum number of subjects for the day, reached maximum time limit for the day, patient was on precautions, patient was previously enrolled in a RED trial or in current trial

† Full intervention = final VPA interaction w/ med rec and interacted with the Web-based VPA

†† Partial intervention = no final, or a partial final, VPA interaction but did receive an AHCP with medications; received final VPA interaction and/or AHCP with meds but did not interact with Web-based VPA post-discharge. Reasons: discharged during un-staffed hours, medication reconciliation unable to be completed.

††† No intervention = did not receive any of the following: final VPA interaction, AHCP, or interact with the Web-based VPA

Twenty-six subjects were allocated to each arm of the study, control and intervention. Of those randomized to receive the intervention, four received the full intervention (final interaction with the In-hospital Louise system, including medications, and interacting with the Post-hospital Louise system), 20 received a partial intervention, which meant either (1) no final In-hospital Louise interaction; 2) partial final interaction and receipt of an AHCP with medications; or 3) final interaction with In-hospital Louise system, no interaction with Post-hospital Louise), and two did not receive any part of the intervention (no final In-hospital Louise, no AHCP, no interaction with Post-hospital Louise). A total of five subjects were excluded from analyses

(control = 3, intervention = 2). Three were found ineligible after signing consent and one person was lost to followup.

The Enrolled Sample. A majority of our sample (n=47) was female (61.7%), between the ages of 40-69 (63.82%), black (65.96%), and single, divorced, separated or widowed (80.85%). Only 15 percent of those enrolled were college graduates, but 70 percent screened with high health literacy. A large majority did not have private insurance (87.23%), but did identify a primary care physician (87.23%) and almost 50 percent reported being disabled. Nearly 13 percent reported being homeless in the last six months, 12 subjects screened positive for depression (25.53%) and over 60 percent had had two or more hospital utilizations in the last six months. Of particular interest for the current study: sixty-eight percent reported having access to a computer in their home. Despite the small sample size, the only significant difference, between the control and intervention groups, in any of the baseline characteristics was that all of the subjects who self-identified as "computer experts" were randomized to the intervention group. Randomization worked for all other variables.

Use of the Post-hospital Louise System by Subjects. Four of 25 intervention subjects eligible for analysis, or approximately 17 percent, signed on to the Post-hospital Louise system over the trial period. The average number of times these subjects signed on was eight and the total number of alerts generated and addressed was 31, which is just less than four alerts per login session.

Post-hospital Louise Users. Four participants in the intervention arm used the Post-hospital Louise system and reported alerts. None of the four had any rehospitalizations or returns to the ED. Of the four, three had a PCP at baseline. All four participants: were not homeless in the six months prior to enrollment; had English as their primary language; were not depressed according to the PHQ9; were in the top REALM category for health literacy; did not use drugs or excessive alcohol; and had a computer to use at home. Income and education were equally distributed across the categories, education ranging from incomplete high school to college degree. Three were female, and three were not married. None of these participants had private insurance – two were on Medicaid, one on Medicare, and one on an unknown or other insurance. Of the four, two were disabled, one unemployed, and one employed part-time. The characteristics of the Post-hospital Louise users are summarized in Table 3.

Table 3. Characteristics of the post-hospital Louise system users

	Frequency	Percent
Age: 30-39	2	50.00
Age: 40-49	1	25.00
Age: 50-59	1	25.00
Gender: F	3	75.00
Gender: M	1	25.00
Marital Status: Single	2	50.00
Marital Status: Divorced/Separated/Widowed	1	25.00
Marital Status: Married	1	25.00
Education: 0	1	25.00
Education: 1	1	25.00
Education: 2	1	25.00
Education: 4	1	25.00
Income: Unknown	1	25.00
Income: None-$19,999	1	25.00
Income: $20,000-$39,999	1	25.00
Income: $75,000 or More	1	25.00
Insurance: Medicaid	2	50.00
Insurance: Medicare	1	25.00
Insurance: Other/unknown	1	25.00
Employment: Disabled/Injured	2	50.00
Employment: Part Time	1	25.00
Employment: Unemployed	1	25.00
Race: Black	2	50.00
Race: Other	1	25.00
Race: White	1	25.00
Born in USA: N	1	25.00
Born in USA: Y	3	75.00
Computer Access: Home	4	100.00
Computer Experience: Use regularly	4	100.00
Feel about Computers: Love using them	4	100.00
Primary Language: English	4	100.00
Been Homeless: N	4	100.00
Has PCP: N	1	25.00
Has PCP: Y	3	75.00
Depression Status: Not Depressed	4	100.00
Frequent Flier: Yes	1	25.00
Frequent Flier: No	3	75.00
REALM: 60-66	4	100.00
Illegal drugs: N	4	100.00
Alcohol: N	4	100.00

Alerts Generated. Each of the 31 alerts was categorized by a Discharge Advocate as relating to: medications (n=9), appointments (n=0), health (n=0), or side effects (n=22). Next, each alert was rated according to the following definitions: not clinically needed, but patient wanted call; minor problem, unlikely to lead to a clinically important issue; minor problem, could potentially become a more serious problem; potential problem that needs followup; problem, needs response in a timely way. We also determined the most appropriate professional level needed to response to each alert. We found that an administrative person could have addressed 12.90 percent of the alerts, while an RN was needed for 58.06 percent and a PharmD would be best to address about 29 percent of alerts.

Of the 31 alerts generated by subjects' use of the Post-hospital Louise, 42 percent (n=13) were rated by the Discharge Advocates as potential problems or problems needing timely responses. Of these 13 alerts, 53.85 percent were determined to be ameliorable or preventable. Reports of possible side effects accounted for 55 percent of the logged alerts. Other common alerts included: inability to pick up medications, intentional non-adherence, and appointment rescheduling. Please refer to Table 5 for additional details.

Table 4. Reutilization by group assignment and post-hospital Louise (PHL) usage

Table 4a. Number of cumulative reutilizations

Number of Cumulative Reutilizations	0	1	2	3	4	5	6
Control	14(61%)	3(13%)	3(13%)	3(13%)	0(0%)	0(0%)	0(0%)
PHL, didn't use	12(60%)	6(30%)	0(0%)	1(5%)	0(0%)	0(0%)	1(5%)
PHL Users	4(100%)						

Table 4b. Number of cumulative rehospitalizations

	0	1	2	3
Control	18(78%)	3(13%)	1(4.5%)	1(4.5%)
PHL, didn't use	16(80%)	4(20%)	0(0%)	0(0%)
PHL Users	4(100%)			

Table 4c. Number of cumulative returns to ED

	0	1	2	3	4	5
Control	16(70%)	4(17%)	3(13%)	0(0%)	0(0%)	0(0%)
PHL, didn't use	14(70%)	4(20%)	1(5%)	0(0%)	0(0%)	
PHL Users	4(100%)					

Table 5. Alerts generated by the post hospital Louise system (n=31)

	Frequency	Percent
Alert Related to: Medications	9	29.03
Alert Related to: Appointments	0	0
Alert Related to: Health	0	0
Alert Related to: Other	0	0
Alert Related to: Side Effect	22	70.96
Alert Rating: Not clinically needed, but patient wanted call(social)	6	19.35
Alert Rating: Minor problem, unlikely to lead to a clinically important issue	8	25.81
Alert Rating: Minor problem, could potentially become a more serious problem	4	12.90
Alert Rating: Potential problem that needs followup	6	19.35
Alert Rating: Problem, needs response in a timely way	7	22.58
Alert Could be Addressed By: Administrative person	4	12.90
Alert Could be Addressed By: RN	18	58.06
Alert Could be Addressed By: PharmD	9	29.03
Alert an Adverse Event?: Outcome definitely due to treatment	3	9.68
Alert an Adverse Event?: Undetermined	12	38.71
Alert an Adverse Event?: No evidence the outcome was due to treatment	8	25.81
Alert an Adverse Event?: Little evidence the outcome was due to treatment	2	6.45
Alert an Adverse Event?: Outcome possibly due to treatment	2	6.45
Alert an Adverse Event?: Outcome probably due to treatment	4	12.90

Table 5. Alerts generated by the post hospital Louise system (n=31) (continued)

	Frequency	Percent
Adverse Event Preventable? (if alert rated as a potential problem or problem needing timely response) n=13: Undetermined	6	46.15
Adverse Event Preventable? (if alert rated as a potential problem or problem needing timely response) n=13: Preventable	3	23.08
Adverse Event Preventable? (if alert rated as a potential problem or problem needing timely response) n=13: Ameliorable	4	30.77
Adverse Event Preventable? (if alert rated as a potential problem or problem needing timely response) n=13: Neither preventable or ameliorable:	0	0
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Undetermined	6	46.15
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Adverse Drug event	4	30.77
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Procedure related injury	0	0
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Nosocomial infection	0	0
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Fall	0	0
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Therapeutic-error (AE due to treatment, other than meds)	3	23.08
Type of Adverse Event (if alert rated as a potential problem or problem needing timely response) n=13: Diagnostic error	0	0

Aim 4: Build a Robust Dissemination Program

Business Development. Through the office of Technology Transfer at Boston University, we have partnered with a small start-up business called Engineered Care™. With our assistance, Engineered Care will be responding to a recently released SBIR solicitation entitled "PHS 2012-02 Omnibus Solicitation of the NIH, CDC, FDA and ACF for Small Business Innovation Research Grant Applications (Parent SBIR [R43/R44])". Within this solicitation, the National Center on Birth Defects and Developmental Disabilities (NCBDDD) has requested applications from small businesses entitled *"Reducing Hospital Readmissions and Post Discharge Venous Thromboembolism (VTE) by the Use of Embodied Conversational Agents to Improve Discharge Planning and Transition of Care"*. We believe that there is great commercialization potential for business opportunities using the products we have developed and, if successful, this SPIR will greatly aid in the expansion of the commercial side of the In-hospital Louise and Post-hospital Louise systems.

Another opportunity we have for disseminating the Post-hospital Louise system is by working with Healthy Circles™. This group is working with Google on its "City of the Future" program where Google is investing over one billion dollars to wire Kansas City with ultrahigh speed Internet. Healthy Circles™ is competing to be the lead health sector contractor and to have their health IT platform be used in the "City of the Future." Healthy Circles™ has asked us if we would include the In-hospital Louise and Post-hospital Louise systems to be a part of the health products used in Kansas City. This is an exciting opportunity that is currently being negotiated.

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