Evaluation of a Mobile Application to Enhance Medication Management Following Hospital Discharge

Research Protocol

April 26, 2019

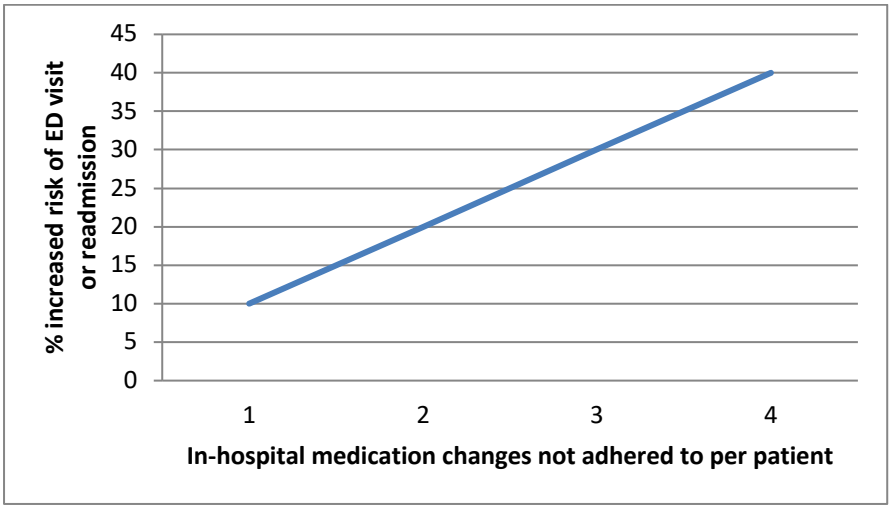
NCT04676165

Background

Adverse drug events (ADEs) are among the leading causes of death in North America[1,2]. Over 2 million ADEs occur each year, resulting in 100,000 deaths and $36 million in economic costs[3]. In recently hospitalized patients, 70% of adverse events that occur within 30 days of discharge are medication related[4,5]. Of these, at least 58% are preventable and tend to be the result of prescribing or dispensing errors, incomplete drug information, and underuse or overuse of medications[6,7].

A number of studies have demonstrated that patients are usually discharged from hospital on substantially different medication regimens than those prior to admission. However, discharge prescriptions are typically not well followed in the community post discharge. We have further explored this phenomenon through secondary analysis of data from a randomized controlled trial (RCT) recently conducted by our study team at the McGill University Health Centre (MUHC), which evaluated the impact of electronic medication reconciliation on ADEs post hospital discharge. Our analyses suggested that 54% of study patients were non-adherent to at least 1 in-hospital medication change, and that patients who were non-adherent to 4 or more in-hospital medication changes experienced a 64% increased risk of emergency department visits and hospital re-admissions compared to those who were adherent to all changes (Figure 1). Furthermore, analyses of patient interview data suggested that unclear communication with patients about medication changes and the reasons for these changes may be driving non-adherence, as might difficulties in managing complex drug regimen information and dosing schedules (data from in-progress manuscript). There is therefore a clear need to implement and evaluate patient support mechanisms that reduce non-adherence to essential changes in therapy following hospitalization.

Figure 1. Impact of non-adherence to in-hospital medication changes on ED visits and hospital re-admission 30 days post discharge.



.

Objective

The objective of this project is to evaluate the usability and efficacy of a mobile application aimed at improving medication management and subsequent adherence to in-hospital medication changes among high risk patients.

Methodology

We will conduct an RCT that will assess the usability of a medication management mobile application and its efficacy in decreasing non-adherence to in-hospital medication changes among patients in the internal medicine ward of the Royal Victoria and Montreal General sites of the MUHC. One hundred patients will be randomized 1:1 to either the intervention arm, in which they will receive access to the mobile app, or the control arm, in which they will receive usual care (i.e., no medication management support). We will conduct a usability assessment at hospital discharge (baseline) and at 1 week post-discharge to obtain patient feedback on the app (via a technology acceptance questionnaire) and to document usability using the "think aloud" protocol[8,9]. We will also compare, between the 2 arms, the rates of non-adherence to treatment changes in the 30-days post-discharge.

Study population

The study population will comprise 100 patients who are discharged from the internal medicine unit of the Royal Victoria and Montreal General sites of the MUHC. To be eligible for participation in the trial, patients must also be covered by the Quebec public insurance drug plan (i.e. they are 65 years or older, are recipients of social assistance, or do not have private drug insurance), must be 18 years or older at the time of admission, must own a tablet, smartphone, desktop PC, or portable computer, must have internet connection on their tablet/smartphone/laptop/PC, must speak and read either English or French, must not be discharged to a rehabilitation or long-term care center, and must have a prognosis of more than 3 months.

Patients who are cognitively impaired or otherwise unable to provide consent will be eligible for inclusion in the study if surrogate consent is granted by a legally authorized representative and if a caregiver has agreed to use the app on the patient's behalf. Similarly, patients who are completely dependent on a caregiver but capable of providing consent will be enrolled only if the caregiver has agreed to use the app.

Participant recruitment, consent, and enrollment

Hospital pharmacists working on the internal medicine ward of the Glen site of the MUHC will briefly introduce patients to the study. During routine collection of community medication information from patients, hospital pharmacists will hand out a flyer that briefly describes the study and will ask patients if they would be interesting in learning more about it. If patients express interest, a study field coordinator will then approach them to assess eligibility and describe the study in more detail to patients. If patients are both eligible and willing to participate, they will be provided with a consent form, which the field coordinator will go over in detail, explaining various aspects such as study objectives and procedures, participant responsibilities, potential benefits and risks of participating, confidentiality of data collected, etc. Patients will be provided an opportunity to ask any questions they might have. If willing to participate, they will then be asked to sign the consent form and will be given a copy of the signed form.

During the enrollment process, patients will also be asked if they wish to authorize a chosen caregiver to access the app. If patients do wish to grant access to a caregiver, information on the caregiver will be collected (name, gender, date of birth, telephone or mobile number, email address, preferred language) and study field coordinators will demonstrate the app and its features to both the patient and caregiver.

If a chosen caregiver is not present at the time of discharge, they will be sent an email that describes the study and the app, as well as provides a link to access the app.

If the patient is cognitively impaired or otherwise unable to provide consent, consent will be obtained from the patient's legally authorized representative. In such cases and in cases in which the patient is capable of providing consent but completely dependent on a caregiver, consent will also be obtained from the caregiver. The caregiver must agree to use the app on the patient's behalf and to undergo the usability assessment at discharge and at 1 week post-discharge.

Randomization and blinding

Permuted block randomization with varying block sizes of 2 and 4 will be used to randomize 100 patients 1:1 to either the intervention or the control group. Random assignment will be conducted using the Statistical Analysis Software (SAS). Given the nature of the intervention, study participants and personnel will not be blinded to group allocation, but data analysts will be.

Intervention

Usual care

At discharge, patients will be provided with a written discharge prescription to be filled at their community pharmacy, and may or may not receive written or verbal instructions about changes made to therapy.

Intervention arm

At discharge, patients (and/or caregivers) will receive access to a medication management application that has been developed by the McGill Clinical and Health Informatics (MCHI) Research Group. The application will retrieve all medications prescribed to patients at discharge from an electronic form with structured data fields that has been completed by a study field coordinator using the patient's discharge prescription. The app will then generate a patient-friendly medication list and will offer a number of important features aimed at addressing barriers to adherence, including:

- **Pill identification**: This feature displays an image of a pill next to each medication in the list, with the intention of ensuring patients take the correct medications at the appropriate dosage and at the right times.
- **Drug information**: Patient-friendly monographs are provided to help patients and caregivers understand the indications for treatment, as well as the harms and benefits of their medications. Improved health literacy with respect to treatment has the potential to increase appropriate utilization of medications by patients.
- **Drug alerts**: Using prescription claims data of the 30 days post-discharge, which will be obtained from the RAMQ, this feature alerts patients to their non-adherence, such as in cases in which they have filled prescriptions that were stopped at hospital discharge, have yet to fill prescriptions for medications newly prescribed at discharge, or have been dispensed medications at the incorrect dose.
- **Daily pill reminders**: This feature reminds patients to take their medication on the day/time they are supposed to. Patients can choose whether or not they want this feature activated.
- **Weekly dosing schedule**: This feature presents patients with an easy-to-interpret schedule of which medications need to be taken and when (with special instructions, e.g. needs to be taken with food). Medication names are displayed with images of the corresponding pill to prevent mix-ups.
- **Symptom checker**: This feature allows patients to enter their symptoms into the application and

determine which of the medications they are taking has side-effects similar to those they are experiencing.

- **Rate my med**: This feature allows patients to rate the medications they are taking (1-5 stars) and comment on how effective they have been or if they have experienced any negative side-effects. Patients can also view ratings given by other patients using the application for medications they have been prescribed.
- **Caregiver connect**: This feature provides the patient's caregiver(s) with access to their medication lists, as well as notifies them of nonadherence to treatment changes, with the aim of reducing its occurrence. Caregivers will have access to all the same information that patients have access to through the app.
- **Pharmacy connect**: This feature allows patients to connect with their hospital pharmacist and ask any questions they might have regarding their discharge prescription, therapy changes, and drug alerts. Based on their communication with the patient, hospital pharmacists then have the option to (1) recommend a course of action to the patient regarding their medications, (2) consult with the attending physician who was on duty at the time of the patient's discharge regarding a potential change in the patient's prescription, (3) contact the patient's community pharmacist to inform them of any errors in dispensation or any changes made to the patient's prescription, and (4) contact the patient's primary care physician, if and as needed.

Pilot-testing the app

Prior to enrolling patients in the study, we will pilot test the app using data from the RightRx study, which was also conducted in the internal medicine units of the MUHC (study #10-180 GEN). Anonymized data of RightRx patients will be fed into the app to test whether the app appropriately lists prescribed medications and generates the appropriate alerts for nonadherence. This process will help us identify any bugs in the app so that we can fix them prior to the app's use in the pilot trial.

Once the 30-day follow-up period is complete, patients will retain access to the application for 1 year. The application will still display medications dispensed to patients (obtained through prescription claims data from the RAMQ) to help them keep track of their medications, but adherence alerts will no longer be generated and the pharmacy connect feature will be modified so that patients' messages are faxed to their community pharmacist, who they will be advised to contact regarding any questions they have. Patients/caregivers will also be able to update their medication list manually.

Outcome measures

Usability assessment

Two measures will be used to conduct usability assessment at baseline (i.e. hospital discharge) and during a follow-up visit at 1 week post-discharge. The first, a technology acceptance questionnaire, is a self-administered questionnaire that patients in the intervention group (or their caregivers) will complete and that will assess their satisfaction with the application and collect their feedback on its usability. The second will consist of observing patients (or their caregivers) as they use the app, following the "think aloud protocol".[8,9] This protocol is widely used to collect data in usability testing[10-13] and involves users verbalizing their thoughts as they perform a standardized set of tasks, while being audio-recorded. In this project, a study field coordinator who is familiar with the mobile application will observe and record intervention patients (or their caregivers) as they access the app and complete the following standardized tasks: view their medications lists and dosing schedule, peruse drug information, and examine any alerts they might have been issued. Each session will then be transcribed and transcriptions will be qualitatively

analyzed to assess the following usability concepts: the technology's (1) ease of use, (2) user-friendliness, (3) efficiency, and (4) features that may cause confusion, frustration, or user errors.

Patients who complete the home visit at 1 week post-discharge will be provided with a gift card in the amount of $20 as compensation for their time.

Non-adherence to treatment changes

Pharmacy claims data from the RAMQ will be used to identify community medications dispensed to participating patients in the 30 days following hospital discharge. These data will be compared with the patient's hospital discharge prescription to identify non-adherence to in-hospital medication changes. Non-adherence to in-hospital treatment changes in the 30-day post-discharge period will be defined as (1) failure to fill newly prescribed medications, (2) re-filling a previous prescription that was stopped at discharge, or (3) filling a previous prescription whose dosage was modified at discharge, but was dispensed post-discharge at the incorrect daily dose.

Data sources

Prescription claims data from the *Régie de l'assurance maladie du Québec (RAMQ)* will be used to identify prescriptions filled in the 3 months prior to admission and the 1 year following discharge.

Medications prescribed at discharge and in-hospital medication changes will be determined using patients' discharge prescriptions, which will be obtained from patients' hospital charts.

Data Analysis

Descriptive statistics will be used to summarize demographic and clinical characteristics of the study population, results of the technology assessment questionnaire, and the frequency of nonadherence events (as defined in the previous section) in the 30 days post-discharge, overall and in each study group. We will then compare, between intervention and control groups, the average number of in-hospital medication changes not adhered to in the 30-day follow-up period using the Student's t-test. All quantitative statistical analyses will be conducted using SAS version 9.4. Data from the "think aloud" protocol will be analyzed qualitatively.

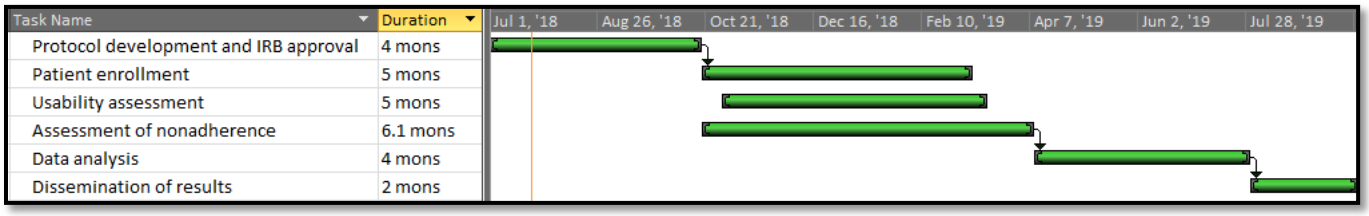
Project timeline

The RCT will be conducted at the internal medicine unit of the Royal Victoria and Montreal General sites of the MUHC over a period of 1.5 years (Figure 2). Following approval of the study by the MUHC's institutional review board, study coordinators will begin recruiting, consenting, enrolling, and randomizing eligible patients who are admitted to the internal medicine unit of the MUHC Glen site. Based on recruitment rates from our recently completed trial which was also conducted at the MUHC, we expect this process to take approximately 5-6 months. At discharge, the study coordinator will provide enrolled patients in the intervention arm with access to the mobile application, enter their discharge prescription into the app, acquaint them with and train them in the various features of the app, and conduct a baseline usability assessment.

One week following discharge, study coordinators will conduct usability assessments at patients' homes. Assessment of non-adherence will be conducted by a data analyst at the MCHI Research Group using data from the RAMQ feed and patients' discharge prescriptions. Subsequent data analyses will be conducted over a period of 4 months, beginning 30 days following the enrollment of the last study patient. All data will be stored on a secure server at the MCHI centre, which can only be accessed using employee

identification cards. Following data analysis, an evaluation report will be disseminated to relevant stakeholders at the MUHC (e.g. Committee of Quality and Risk), and a manuscript will be prepared for potential publication in a peer-reviewed journal.

Figure 2. Gantt Chart.



Data storage, privacy, and confidentiality

An account will be created for each newly consented and enrolled patient using their first and last names. Data collected via the mobile application and acquired from the RAMQ and patients' hospital records will be stored on secure servers at the McGill Clinical and Health Informatics Research Group with daily backup. Information collected on caregivers (name, gender, date of birth, telephone or mobile number, email address, preferred language) will also be stored on these secure servers. Patient identifying information will be replaced with unique encrypted numbers and the file linking these unique numbers to patients' names will be accessible only by the Principal Investigator (Robyn Tamblyn) and the system administrator. All research staff involved in this project and who have access to study data will sign confidentiality agreements.

No data or information from the app will be accessible by third parties; only the patient, their chosen caregiver, the hospital pharmacist, Dr. Tamblyn, and Dr. Tamblyn's research team will have access to data in the app. Furthermore, the app will not be able to access any other apps on the patient's (or caregiver's) device, nor will it access any personal information besides that which has been entered into the app or has been obtained from the RAMQ or the patient's discharge prescription. Once the 30-day follow-up period of the study has ended, the patient/caregiver will retain access to the app and the app will continue to be linked to the RAMQ to display dispensed medications; however, the app will no longer display nonadherence alerts and will not connect patients to hospital pharmacists (messages patients enter into the feature will instead be faxed to their community pharmacists, who they will be advised to contact). Patients/caregivers will also be able to update their medication list manually.

The backend/server of the app will be hosted on the McGill network. The network is a highly restricted environment with no access to the internet. The user accesses the app via a remote proxy server which acts as a mediator from the internet to the server. A robust firewall system restricts access to and from the server to the internet. There is also a campus-wide antivirus system that monitors network traffic and keeps our systems safe. User access directly to the server is highly restricted to the support staff and is logged.

Any research publications related to this study will present data in aggregate form only. Study data will be used for the exclusive purposes described in this protocol and will be retained for a period of 7 years following study completion, after which they will be destroyed.

Project monitoring mechanisms

We will monitor consent and enrollment rates weekly to ensure we are meeting expected targets and will modify procedures accordingly if needed. We will also continually monitor use of the mobile application throughout the 30-day follow-up period to ensure patients are utilizing the app consistently for its intended purposes.

References

1. Rosenbloom D, Wynne C. Dectecting adverse drug reactions. *Canadian Medical Association Journal.* 1999;161(3):247.
2. Lazarou J, Pomeranz BH, Corey PN. Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies. *Jama.* 1998;279(15):1200-1205.
3. Wu C, Bell CM, Wodchis WP. Incidence and economic burden of adverse drug reactions among elderly patients in Ontario emergency departments: a retrospective study. *Drug safety.* 2012;35(9):769-781.
4. Forster AJ, Clark HD, Menard A, et al. Adverse events among medical patients after discharge from hospital. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne.* 2004;170(3):345-349.
5. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Annals of internal medicine.* 2003;138(3):161-167.
6. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events. ADE Prevention Study Group. *Jama.* 1995;274(1):35-43.
7. Bell CM, Bajcar J, Bierman AS, Li P, Mamdani MM, Urbach DR. Potentially unintended discontinuation of long-term medication use after elective surgical procedures. *Archives of Internal Medicine.* 2006;166(22):2525-2531.
8. Charters E. The Use of Think-aloud Methods in Qualitative Research: An Introduction to Think-aloud Methods. *Brock Education Journal.* 2003;12(2).
9. Cooke L. Assessing Concurrent Think-Aloud Protocol as a Usability Test Method: A Technical Communication Approach. *IEEE Transactions on Professional Communication.* 2010;53(3):202-215.
10. Bond RR, Finlay DD, Nugent CD, Moore G, Guldenring D. A usability evaluation of medical software at an expert conference setting. *Computer Methods and Programs in Biomedicine.* 2014;113(1):383-395.
11. Siek KA, Khan DU, Ross SE, Haverhals LM, Meyers J, Cali SR. Designing a Personal Health Application for Older Adults to Manage Medications: A Comprehensive Case Study. *Journal of Medical Systems.* 2011;35(5):1099-1121.
12. Simon AC, Holleman F, Gude WT, et al. Safety and usability evaluation of a web-based insulin self-titration system for patients with type 2 diabetes mellitus. *Artificial intelligence in medicine.* 2013;59(1):23-31.
13. Harris LT, Tufano J, Le T, et al. Designing mobile support for glycemic control in patients with diabetes. *Journal of Biomedical Informatics.* 2010;43(5, Supplement):S37-S40.