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An Evaluation of the Impact of Clinical Pharmacists on Care Transitions in a Non-Integrated Healthcare System

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An Evaluation of the Impact of Clinical Pharmacists on Care Transitions in a Non-Integrated Healthcare System

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Health Policy and Management

by

Andrea Sorensen

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ABSTRACT OF THE DISSERTATION

An Evaluation of the Impact of Clinical Pharmacists
on Care Transitions
in a Non-Integrated Healthcare System

by

Andrea Sorensen
Doctor of Philosophy in Health Policy and Management
University of California, Los Angeles, 2018
Professor Carol M. Mangione, Chair

Medication errors and medication non-adherence can contribute to adverse drug events, poor health outcomes, and avoidable hospitalizations and emergency department (ED) visits. Patients are at increased risk for medication-related problems during transitions of care. The causes include inaccuracies in medication lists upon admission to the hospital, documentation errors caused by inadequate communication among providers, and insufficient education provided to patients regarding changes to their medication regimens. The objective of this dissertation is to evaluate the impact of two care transition interventions at UCLA Health that aimed to reduce hospital readmissions and ED visits by improving medication accuracy and patient adherence to medications following hospitalization.

The analyses undertaken in this dissertation use health system administrative data to (1) evaluate the impact on hospital readmissions and ED visits of a hospital to home care transitions program that included a home visit by a health coach, and a review and modification of medications as needed by a clinical pharmacist in coordination with the patient's primary care provider; (2) document the prevalence and types of medication-related problems and discrepancies that occur and persist following a patient's transition from hospital to home; and (3) evaluate the impact on hospital readmissions and ED visits of a pilot program that used a clinical pharmacist in a skilled nursing facility (SNF) to manage medications between the hospital, post-acute care setting, and home. Propensity score and multivariate regression approaches as well as qualitative methods were used to evaluate the interventions.

Results from the first study showed that receipt of the intervention was associated with a significantly lower predicted probability of hospital readmissions and ED visits compared with usual care. Results from the second study revealed that clinical pharmacists identified and took action on a wide range of medication discrepancies and medication-related problems following a patient's hospitalization. Results from the third study showed that patients who were discharged from a SNF to home and who were under the care of a clinical pharmacist had a significantly lower likelihood of being readmitted to the hospital compared with similar patients who received usual care. In summary, the results demonstrate that clinical pharmacists can play an important role in decreasing the risk of poor outcomes following care transitions, and that strengthening the linkage with the primary care system is a potentially necessary component for facilitating safe and effective care transitions.

This dissertation of Andrea Sorensen is approved.

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Chapter I. Introduction

1.1 Overview of Dissertation

This dissertation evaluates a system-wide intervention at UCLA Health that aimed to improve patient care and outcomes by embedding clinical pharmacists in primary care settings. The goals of this program were to improve medication accuracy, reduce harmful drug-drug interactions and polypharmacy, and to improve patient adherence and management of chronic diseases for high-risk patients. The program was implemented in 2012 and several early evaluations demonstrated the program's effectiveness in reducing blood pressure, hemoglobin A1C—a marker of diabetes control—and emergency room utilization. The success of the program in the ambulatory setting led to the program's extension to care transitions between the hospital and home, and the post-acute care setting and home. The studies in this dissertation investigate the impact of these interventions on patient outcomes and utilization, and attempt to better understand the pathways by which clinical pharmacists can influence patient outcomes during transitions of care. The Specific Aims are as follows:

(1) Evaluate the impact on hospital readmissions and emergency department (ED) visits of a hospital to home care transitions program that included a home visit by a health coach in coordination with a clinical pharmacist embedded in the patient's primary care setting.

(2) Understand the prevalence and types of drug-related problems and medication discrepancies that occur and persist following a patient's transition from hospital to home.

(3) Evaluate the impact of a care transitions pilot program that used a clinical pharmacist in a skilled nursing facility (SNF) to manage medications, educate patients and caregivers,

and communicate potential problems and recommendations to a patient's primary care provider (PCP) using the health system's electronic medical record (EMR).

This first chapter introduces (1) the challenges associated with medication accuracy and medication adherence in the U.S. healthcare system, (2) a provider-driven intervention at UCLA Health that was developed to address medication challenges, (3) an overview of the studies included in this dissertation, and (4) the contributions of these studies to the literature. The second chapter reviews the conceptual framework that underpins the three studies. The third, fourth, and fifth chapters include the background and study objectives, methods, results, and conclusions. Chapter six summarizes the findings and the implications for the health services research field and clinical practice. Lastly, the two appendices include variable construction, variable definitions, full regression model results, sensitivity analysis results, as well as documents used to support the interventions (e.g., workflows, documentation forms used by clinical pharmacists).

1.2 Medication Errors and Medication Non-adherence

To Err is Human: Building a Safer Health System, the seminal report published by the Institute of Medicine (IOM) in 2000, brought attention to several underperforming areas within the U.S. healthcare system related to quality and patient safety. The report emphasized that these problem areas were not so much the result of incompetence, but rather poorly-designed delivery systems. Medication-related errors and adverse drug events in both the inpatient and outpatient settings were prominently highlighted in the report as common contributors to hospitalizations, hospital readmissions, and emergency room visits (1). Expanding on this work, a follow-up report was published in 2007 by the IOM's Committee on Identifying and Preventing Medication Errors (2). The purpose of this report was to review the evidence on factors that contribute to

medication-related errors, estimate the severity and costs of these problems, investigate potential solutions to address medication errors across the healthcare continuum, and provide recommendations to the academic community about priority areas for research. Key recommendations for improving medication safety for providers and health systems included that providers adopt a patient-centered, multi-disciplinary team based approach for medication management; that leadership invest in and support programs that promote medication safety; that careful consideration be made to implement and use technology in ways that promote safety, and facilitate interoperability to enable the sharing of patient clinical information; and that process and outcome measures be continuously monitored (2).

In the wake of these reports and as a result of the increased attention they brought to medication-related challenges, Congress called for the Centers for Medicare and Medicaid Services (CMS) to devise a national agenda in coordination with the IOM for addressing medication safety. Other government agencies and organizations including the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Network, the Joint Commission, and the Institute for Healthcare Improvement similarly identified medication errors and medication non-adherence as priority areas for patient safety, and allocated substantial funds for reducing medication problems (3, 4). These organizations also called for new measures such as requiring medication reconciliation for patients at the time of discharge from the hospital, and medication therapy management (MTM) programs for certain patient populations (5, 6).

Recent policy changes such as the Readmissions Reduction Program, which took effect in 2012 and penalizes hospitals that exceed a certain threshold for risk-adjusted hospital readmissions, have also brought attention to and further incentivized health systems to focus on patient safety, including medication safety, with the goal of reducing avoidable inpatient

utilization (7). Among Medicare patients, approximately 20% are readmitted within 30 days of discharge with associated costs of $26 billion per year (8). Related to this is the movement towards new care models such as accountable care organizations (ACOs), which increase accountability among providers for patient outcomes with the goal of encouraging better coordination of care across the continuum. These policies have played an important role in incentivizing health systems and providers to identify and implement strategies that improve patient care following hospital discharge.

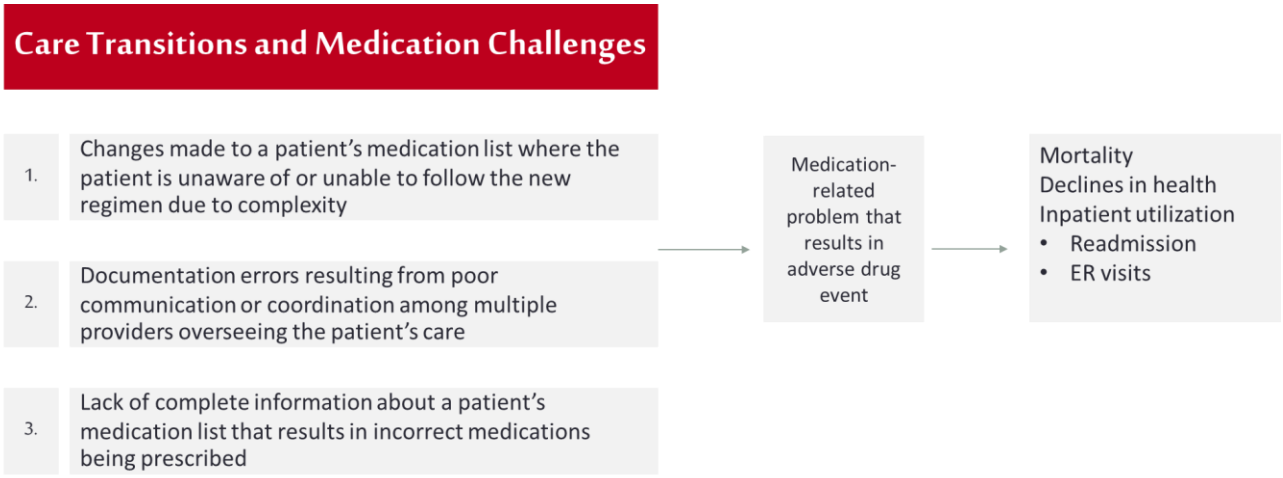
Despite the heightened awareness and policy efforts to address patient safety issues and known contributors to hospital readmissions, health systems and providers continue to grapple with how to reduce medication-related errors, and improve medication prescribing and patient adherence. Medication non-adherence, a key contributor to adverse drug events and mortality, is estimated to be 50% (9, 10). Annually, medication non-adherence is responsible for an estimated 125,000 deaths, 100,000 hospitalizations, and 700,000 emergency department visits (11-13). Costs associated with medication non-adherence range from $100-$289 billion per year (10, 14). Adverse drug events, a potential outcome of non-adherence, are still the most common type of problem patients experience post-hospitalization (15). One recent study estimated that adverse drug events are responsible for 13% of preventable readmissions (16). That medication-related problems still remain so prevalent could be partly attributed to the aging population, and to the fact that prescription drug use continues to increase on an annual basis. For individuals age 65 and older, 13.8% took five or more prescription drugs between 1998-1994. Between 2013 and 2014, this percentage had increased to 42.2% (17).

1.3 Medication Challenges during Transitions of Care

"Transition of care" is defined by CMS as "the movement of a patient from one setting of care (hospital, ambulatory primary care practice, ambulatory specialty care practice, long-term care, home health, rehabilitation facility) to another" (18). Medication-related problems (MRPs) for patients are common in general, and even more so during transitions of care. There are several reasons for this. New medications can be initiated during hospitalization, and others discontinued, with the expectation that the patient will be aware of the new regimen, and have the wherewithal to adhere to the newly-prescribed regimen once home (19-21). Similarly, the number of changes made to a patient's medication list and the multiple providers that care for a patient during an inpatient stay can increase the likelihood of medication discrepancies and documentation errors. Providers at a particular location also may not have access to a patient's full list of medications upon intake to the hospital because most electronic medical record (EMR) systems are not interoperable across non-integrated settings. This lack of full information can result in medications being prescribed that might not be otherwise (e.g., duplications, contraindicated medications).

In the inpatient setting, studies that have assessed medication discrepancies at the time of intake have found that over two thirds of patients have errors in their medication list (22), and studies that have assessed medication discrepancies and errors at the time of discharge from hospitals have found they occur in 41% to 54% of cases (23). Such documentation errors or confusion around medications have been identified as contributors to adverse drug events and subsequent hospital readmissions and ED utilization (20, 21, 24). The figure below characterizes how these three streams can each contribute to a patient experiencing a medication-related complication that requires inpatient utilization following discharge from the hospital.

Figure 1-1: Care Transitions and Medication Challenges



1.4 The Role of Clinical Pharmacists in Team-Based Care Models and Care Transitions

Clinical pharmacists are increasingly being recognized as important members of team-based care models in the primary care setting. Clinical pharmacists are trained in medication reconciliation, medication therapy management, medication regimen adjustments (e.g., substituting therapeutically equivalent and cost-effective medication alternatives), identification of potentially harmful drug-drug interactions, and identification of medication side effects. Clinical pharmacists can titrate medications, provide education, and perform medication reconciliation, all of which support disease management (25-27). In California, the scope of clinical pharmacists was further expanded with the passage of SB 493 in 2013. The law grants pharmacists the opportunity to obtain Advanced Practice Pharmacist (APP) licensure and recognition. This allows pharmacists to, for example, initiate or discontinue certain prescriptions, order lab tests, and refer to providers (28).

Clinical pharmacists have the potential to play an effective role during care transitions, particularly in providing continuity in medication management, and in educating patients about drug regimens and strategies to improve adherence. There is a growing body of literature that

demonstrates the positive impacts of clinical pharmacists. For example, pharmacist-physician collaborative treatment has shown reduction in systolic blood pressured compared with usual care (29-31). Patients with diabetes cared for by community pharmacists have experienced improvements in mean hemoglobin A1C and LDL-cholesterol (32). Randomized controlled trials (RCTs) have shown that pharmacist MTM programs increased the proportion of patients at blood pressure goal from 16 to 48 percent (33). Pharmacist services have also shown a favorable return-on-investment (34).

Several care transition programs have used clinical pharmacists to improve care transitions between the hospital and home, and have demonstrated significant benefits with regard to reducing adverse drug events, ED use and, in some cases, reducing hospital readmissions (35-41). These models have typically used a multi-disciplinary care team approach, and have included several components such as patient education during hospitalization to promote self-management, workflows designed to improve communication and information exchange among care providers, and follow-up communication between providers and patients after discharge. Among the most widely-adopted care transition models that have been deployed by health systems nationally include Project Re-Engineered (Project RED), the Transitional Care Model (TCM), and the Care Transitions Intervention (CTI) (42). The main components of the models and key findings from evaluations of interventions that have tested the models are described below.

- Project RED: This nurse-led model, developed at Boston University Medical Center, aims to improve the hospital discharge process by focusing on several aspects of patient safety by initiating the care transition process before a patient is discharged from the hospital. The intervention involves multiple components including educating a patient

about his or her condition with the intention of improving self-management skills, improving care coordination among providers after a patient is discharged from the hospital, reviewing medications prior to discharge, sharing of the patient's discharge summary with care team members, and phone calls made by a pharmacist two to four days after a patient is discharged. In an RCT, intervention patients had a significantly lower combined rate of 30-day hospital readmissions and 30-day ED visits compared with control patients (43).

- TCM: This nurse-led model, developed by Mary Naylor at the University of Pennsylvania, focuses on older, high-risk patients who suffer from multiple chronic conditions. While a nurse serves as the primary point of contact, the model relies on a multidisciplinary care team comprised of pharmacists, physicians, and social workers. Components of the model include patient education focused on the patient's disease or condition during the inpatient stay, medication reconciliation, and multiple home visits—nurses conduct eight home visits in the three months following the patient's discharge from the hospital. The nurses also coordinate with the patient's primary care physician (PCP). Several studies that have tested this model have found significant reductions in hospital readmissions and ED visits (44-46).
- CTI: This model, developed by Eric Coleman at the University of Colorado, focuses on elderly patients with complex needs. It emphasizes self-management with a focus on equipping patients with the skills needed to successfully manage their diseases and conditions after hospital discharge. An advanced practice nurse called a "transition coach" meets with patients before discharge and conducts one home visit and follow-up phone calls in the weeks following discharge to help the patients hone skills in several

areas including medication management. The transition coach also helps patients recognize when symptoms require medical care, and helps to arrange follow-up care with the patient's PCP and specialists post-discharge. Patients are also guided in creating their own "personal health record," which they keep up-to-date and take with them to all medical appointments. This model has been associated with a significant reduction in readmission rates (47).

While these programs have been effective in reducing utilization and costs, their resource-intensive nature may prevent health systems from implementing them. In addition, when interventions have many components, it is challenging to determine which components may be more effective than others (48). There have been a small number of studies that have attempted to home in on the effect of the clinical pharmacist in the context of care transitions. Gillespie et al. (2008) found a significant reduction in ED visits and readmissions in patients over the age of 80 when clinical pharmacists performed medication reconciliation at the time of discharge from the hospital (49). In another study, Dudas, Bookwalter, Kerr, and Pantilat (2001) used clinical pharmacists to make follow-up phone calls to patients after discharge from the hospital to home during which the pharmacist asked patients about medications. This was an RCT where the outcome of interest was whether or not patients were satisfied with the discharge instructions they received around their medications, and whether those who received the phone call had a lower rate of ED visits after 30 days. Those in the intervention group had significantly higher satisfaction and significantly lower rates of ED use (50). Schnipper et al. (2006) investigated the impact of counseling by a clinical pharmacist at the time of discharge from hospital to home and a follow-up phone call. The pharmacists focused on medication accuracy and barriers to patient adherence. Results from this RCT showed that significantly more

preventable adverse drug events were identified and addressed for intervention patients, and that readmissions and ED visits attributable to ADEs were significantly lower among intervention patients (35). One of the goals of the studies in this dissertation is to build on this work and determine if care transition models that focus specifically on pharmacist-led medication management can achieve similar outcomes as the more comprehensive care transition programs.

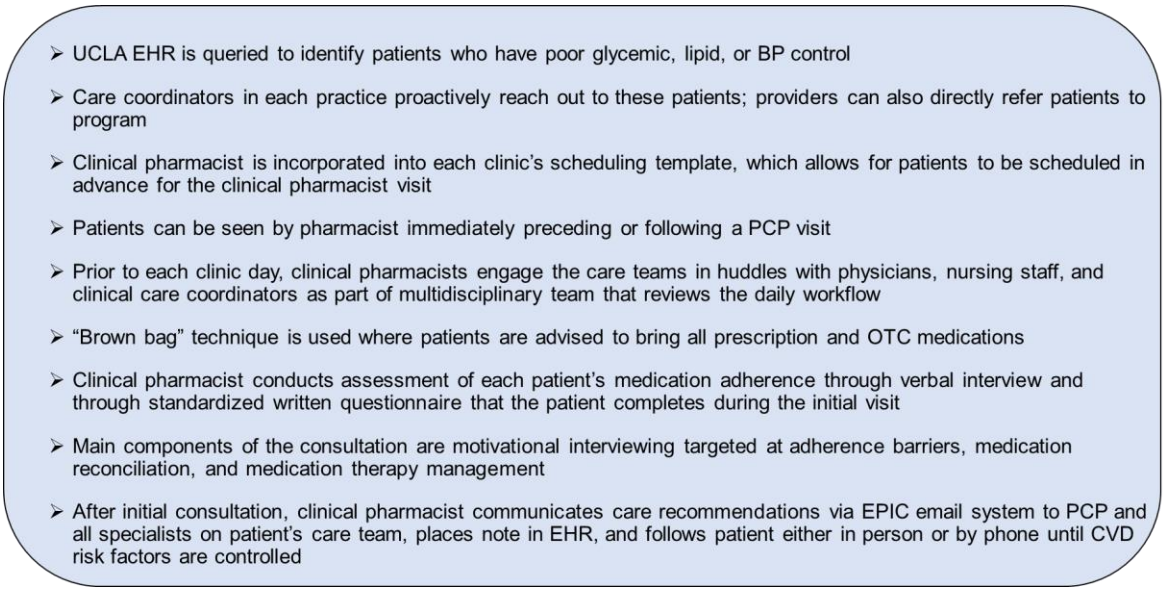
1.5 MyMEDS at UCLA Health

Recognizing the challenges associated with medication prescribing and patient adherence, and taking into consideration the improvements in health outcomes associated with the use of community-based pharmacists (32), UCLA Health developed and implemented an innovative program called Managing your Medications for Education and Daily Support (MyMEDS). The program, which began in 2012, was developed in part to address the expected influx of covered lives under the Patient Protection and Affordable Care Act (ACA), and to re-tool primary care teams as part of UCLA Health's Patient Centered Medical Home efforts. The goals of the program were to (i) improve medication adherence, (ii) decrease polypharmacy, (iii) reduce medication costs, (iv) improve safety, and (v) better manage uncontrolled diabetes, hypertension, and hyperlipidemia.

MyMEDS was designed to fully enfranchise the clinical pharmacists embedded in the primary care practices, and allow these providers to work to the top of their license. As part of a primary care team, clinical pharmacists offer several capabilities that augment patient care beyond what a primary care physician (PCP) can typically provide to patients. The MyMEDS pharmacists are advanced care pharmacists, which means that in addition to completing their doctoral training, they also completed a one-year outpatient residency in a primary care practice. The MyMEDS pharmacists are also trained in motivational interviewing, shared decision

making, assessing barriers to medication adherence, and patient self-efficacy. This training allows the clinical pharmacists to not only review medication lists for accuracy, but also to explore patient-level barriers to adherence such as medication costs, side effects, and beliefs and attitudes towards taking medications. The MyMEDS infrastructure and workflows are arranged so that all care team members work from and communicate with each other using the same medication list in CareConnect, the UCLA Health EMR.

Figure 1-2: Components of the MyMEDS Intervention and Clinic Workflow



MyMEDS is novel in that it is among the first primary care-focused clinical pharmacist interventions in a large, non-integrated health system. In the primary care setting, integrated systems including the VA and Kaiser have employed clinical pharmacists in team-based care settings. These types of programs have been associated with improved clinical outcomes for patients with diabetes, hypertension, and hyperlipidemia (26, 30, 51-54).

1.6 Success of the MyMEDS Program and its Extensions to Other Care Settings

The MyMEDS program has been associated with significant improvements in health outcomes and utilization. Since the program began in 2012 as a pilot study in five clinics, clinical pharmacists are now embedded in over 30 UCLA Health primary care practices and have conducted over 7,000 patient consultations. The program has been associated with reductions in emergency department utilization, as well as improvements in hemoglobin A1C, blood pressure control, and cholesterol levels (55-58). Because of its effectiveness, the MyMEDS program was extended to other settings including home-based care and post-acute care.

In the home-based setting, UCLA Health collaborated with a community organization, Partners in Care Foundation (PICF), to deploy health coaches to patients' homes after acute hospitalization. During the home visit, the community health worker located all prescription medications bottles, reviewed these with patients and/or caregivers, and used a structured template to record all of the prescription and non-prescription medications on an I Pad. This information was electronically transmitted to a MyMEDS clinical pharmacist who conducted a review of all medications to identify duplicate prescriptions, potentially dangerous interactions, and other medication-related problems. The information gleaned through this review and treatment recommendations to improve medication safety and management was shared with the patient's PCP via a structured, efficient communication that used the "in-basket" of the UCLA EMR. In the post-acute care setting, the UCLA Health MyMEDS leaders collaborated with an affiliated SNF to investigate the impact of embedding a MyMEDS clinical pharmacist in the post-acute care setting. The pharmacist reviewed medications at the time of transition from the acute care hospital to the SNF, and from the SNF to home, and also provided education to patients and/or caregivers to improve self-management. This dissertation evaluates these

programs that leveraged the existing MyMEDS infrastructure to improve medication-related problems for older adults that can occur during care transitions.

1.7 Summary of Dissertation Studies

(1) HomeMeds Utilization Outcomes

The first study in this dissertation evaluates the impact of the home visit intervention. The impact of the intervention is measured by comparing the predicted probability of being readmitted to the hospital or experiencing an ED visit among intervention patients as compared with similar patients who receive usual care. This was a non-randomized retrospective observational study that used a control group identified by propensity score matching. UCLA Health administrative data were used to evaluate the outcomes of interest. The protocol was approved by the institutional review board of the University of California, Los Angeles (UCLA).

(2) HomeMeds Qualitative Review of Patient Charts

The second study builds upon the first study by using qualitative research methods to more fully understand the pathways by which clinical pharmacists can influence outcomes in the context of care transitions. For this study, 100 intervention patient charts were randomly selected and reviewed by two independent reviewers. A template with 13 categories was used to document what MRPs the clinical pharmacist identified, and what specific actions were taken and recommendations were made by the clinical pharmacist to mitigate drug-related problems. The protocol was approved by the institutional review board of the University of California, Los Angeles (UCLA).

(3) Post-acute Care Utilization Outcomes

The third study investigates whether patients who are under the care of a MyMEDS clinical pharmacist during a SNF stay (i.e., the pharmacist reviews the patient's medication list to correct discrepancies and simplifies medication regimens where possible, provides a detailed hard copy list to the patient at the time of discharge, and meets with the patient at the time of discharge), have improved outcomes as measured by a lower likelihood of 60-day hospital readmissions and ED visits compared with patients who were not under the care of a clinical pharmacist. This was a non-randomized retrospective observational study that used a control group comprised of patients from 12 UCLA-affiliated SNFs that did not have a MyMEDS pharmacist assigned to the setting. UCLA Health administrative data were used to evaluate the outcomes of interest. The protocol was approved by the institutional review board of the University of California, Los Angeles (UCLA).

1.8 Contribution to the Literature

The purpose of this dissertation is to investigate the potential impact of clinical pharmacists, particularly in the context of care transitions across different settings. While clinical pharmacists have been used in comprehensive care transitions models, and while there has been investigation of the impact of clinical pharmacists in the inpatient setting (59), literature specifically focused on the most effective use and best practices for clinical pharmacist-anchored interventions is limited (60). In the post-acute care setting, literature on this topic is nearly non-existent (61). The evaluation of these pragmatic, health system-based interventions that also use outside partners may serve as guides to other providers considering how to maximize the use of clinical pharmacists, and how to implement less resource intensive and potentially lower cost interventions that improve medication management and reduce inpatient utilization.

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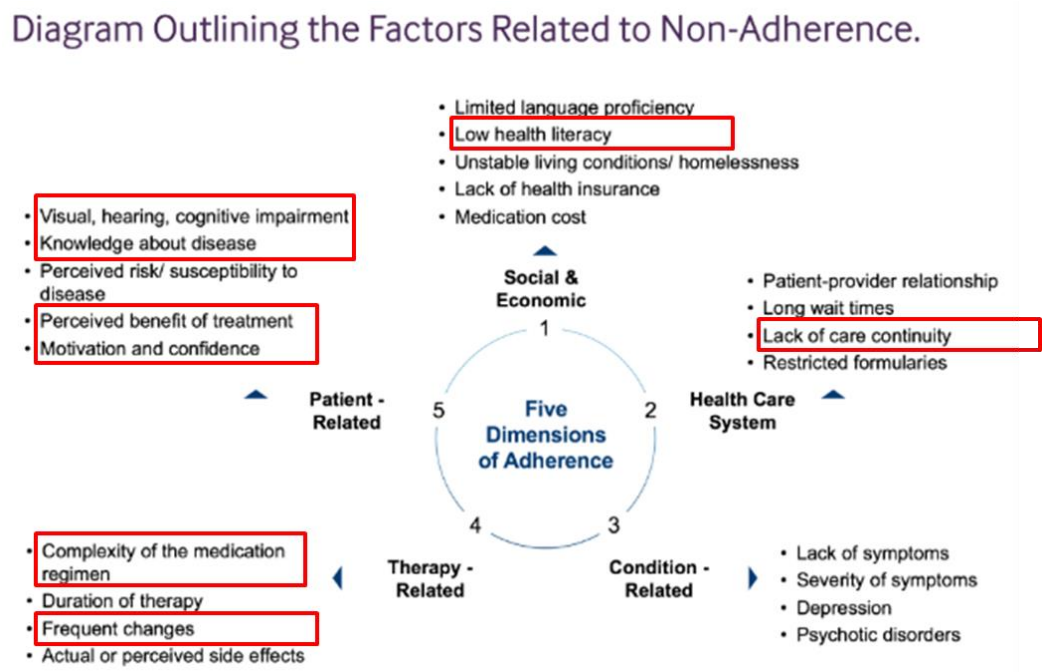
Chapter II. Conceptual Framework

2.1 Conceptual Framework for Medication Accuracy and Patient Adherence

The UCLA Health MyMEDS program and the studies undertaken in this dissertation used the World Health Organization's (WHO) Adherence to Long-term Therapies Model as a conceptual framework for developing the MyMEDS intervention (1). Figure 2-1 below shows the WHO's adherence to long-term therapies model, and highlights the specific components that the UCLA Health interventions sought to address. The studies undertaken in this dissertation also used the Chronic Care Model in analyzing health system factors thought to facilitate effective prescribing of and adherence to medication regimens (2, 3). The model recognizes the influences of patient, provider, system, and policy-level factors and the relationships between them on health outcomes. Figure 2-2 illustrates some of the elements of the MyMEDS interventions that align with features of the Chronic Care Model.

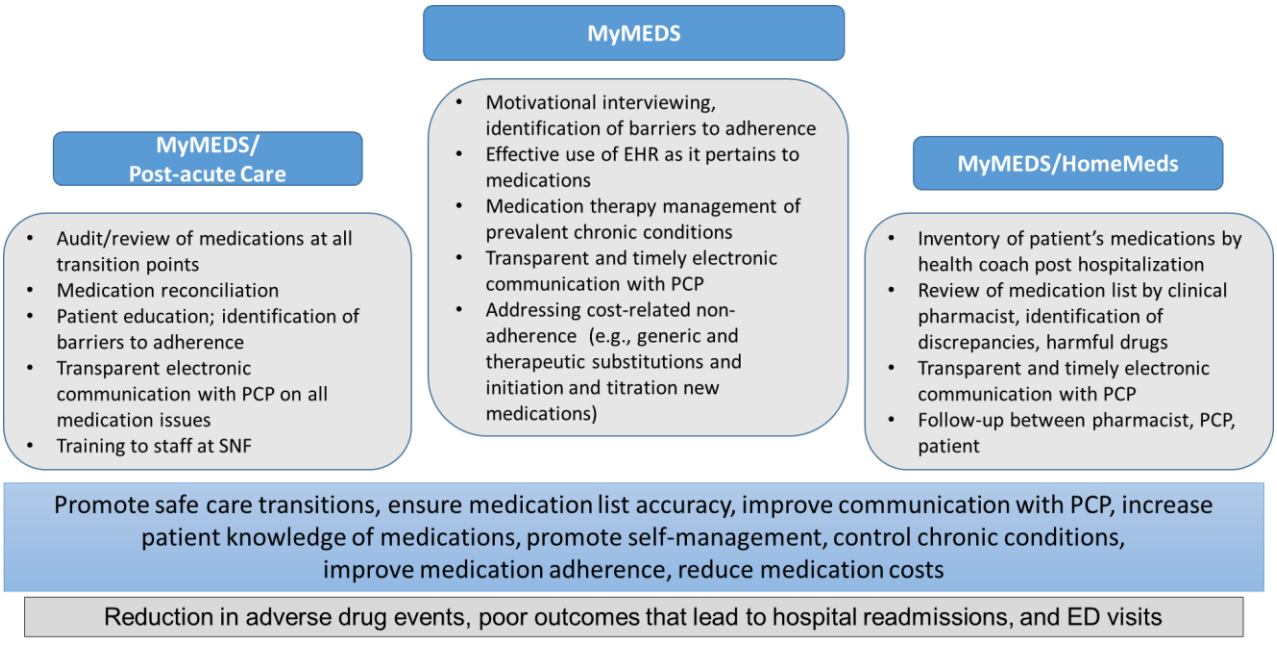
Figure 2-1: World Health Organization Adherence to Long-term Therapies



2.2 Provider and system-level factors

MyMEDS and its extensions that aim to improve care transitions were motivated by the recognition that factors at the provider and health system-levels play a role in outcomes following care transitions. The following figure depicts features and goals of the interventions, and offers a theory as to what health systems can do to reduce poor outcomes. Factors at the provider level that can be addressed include improving medication list accuracy; reducing polypharmacy for patients; communicating with and educating patients to promote self-management and adherence to medications; and allotting sufficient time for provider and patient interaction so that medications, patient preferences and values as they relate to medications can be discussed.

Figure 2-2: MyMEDS Intervention Components and Goals



Provide Knowledge and Communication with Patients about Medications

Communication with providers who have advanced knowledge about medications (i.e., those who have the training and knowledge around medications and have the time to devote to these conversations) is critical to ensure that education provided to patients is accurate and understandable. Providers who are knowledgeable about medications can also influence a patient's prescription regimen by, for example, making it as simple as possible, and ensuring that drugs prescribed are covered by a patient's insurance so that out-of-pocket costs are not a barrier to adherence. The type and intensity of communication (e.g., follow-up calls, in-person meetings between the provider and patient before a patient is discharged) can also contribute to improved adherence. Even if a patient initially has a low level of health literacy, is apprehensive about taking a medication, or has cultural views that might impede adherence, conversations between the patient and provider and medication education can act as moderators and increase the likelihood of medication adherence.

The provider-patient relationship, specifically trust between patient and provider, can also play an important role in patient adherence. This can be especially important for a patient's continuation of medications when symptoms start to improve, when there are no symptoms (e.g., hypertension, high cholesterol), when medications cause symptoms, or when a patient has a negative perception of using medications. The level of trust can develop or be improved if the provider has sufficient time to spend with the patient and actively listen to their concerns. Education around medications, educational materials, and the method by which information about medications is shared with the patient can also influence the pathway. Motivational interviewing and shared decision making—techniques where barriers to adherence are identified

and solutions are discussed, and where a patient's values and preferences are taken into account when various treatment options are available—can also increase the likelihood of adherence.

2.3 Health system-level factors

At the health system level, mechanisms in place to ensure prescription accuracy can reduce a patient's likelihood of experiencing a medication-related problem (MRP) after discharge from the hospital. Computer monitoring systems and electronic medical records (EMRs) can reduce the potential for harmful drug-drug interactions, medication discrepancies, and inappropriate dosage of drugs. The proliferation of these systems in recent years, however, has not proven to be a panacea for eliminating medication inaccuracies. With transitions of care, interoperability is also important so that providers can view a patient's medication list after a patient has transitioned to a different setting. Leadership and organizational support that encourages clinical staff to focus on medications during care transitions is also important for sustainability and for promoting a culture of patient safety around medications.

2.4 External-level factors

External factors such as policies, penalties, and reimbursement can also influence the pathway between care transitions, MRPs, and medication related hospitalizations. The CMS hospital readmission policy that penalizes hospitals that exceed a certain threshold of readmissions is hypothesized to incentivize hospitals to develop comprehensive discharge programs that improve patient transitions between the hospital and home. Complying with requirements or recommended guidelines around medication review and reconciliation at hospital discharge is also hypothesized to decrease medication-related complications. New payment models like accountable care organizations that aim to improve care coordination and increase accountability among providers could also provide such incentives. These external

policy levers can encourage health systems to invest in clinical and non-clinical staff that focus on optimal regimens and patient adherence.

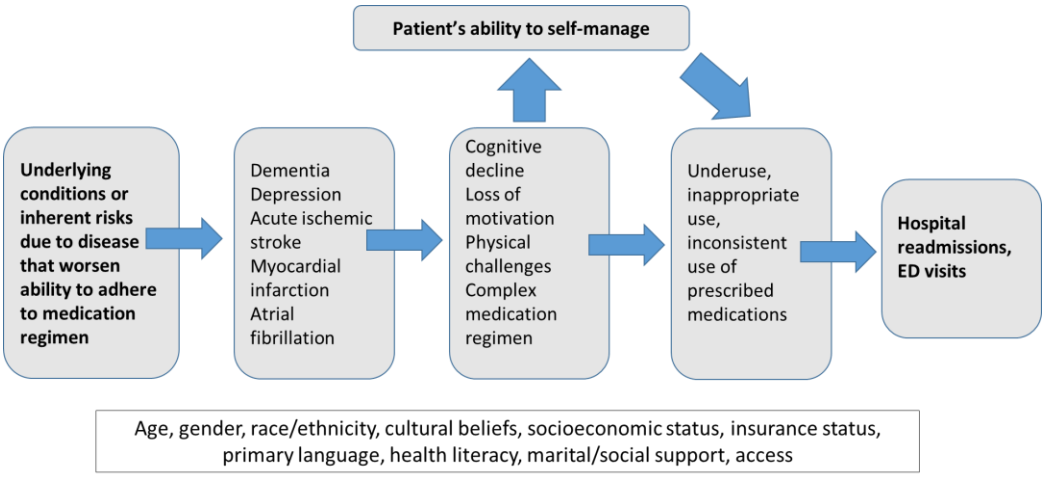
2.5 Patient-level factors

The patient-level factors that can influence the causal pathway and the outcome of interest—experiencing an adverse drug event (ADE) that results in inpatient hospitalization—can be organized into two streams: (1) a patient's underlying conditions or inherent health risks due to disease, which influences their ability to self-manage and avoid an ADE and subsequent utilization, and (2) demographic and other patient-level factors that mediate and moderate along the pathway. The ability to self-manage will be more difficult if a patient has certain conditions such as dementia, depression, poor social support, or has suffered a stroke. While none of these conditions fall directly on the path to the outcomes of interest (i.e., having dementia does not directly cause hospital readmissions), these conditions can contribute to memory loss, cognitive decline, loss of motivation, and physical challenges that make it difficult for the patient to manage medications without assistance, potentially increasing the likelihood of an ADE that leads to hospitalization.

A patient's underlying health conditions and the medications required to manage those conditions can similarly decrease the likelihood of being able to adhere to a regimen. Certain medications—insulin for diabetic patients, anticoagulants or antiplatelet agents for patients who have experienced venous thrombosis, acute ischemic stroke, or cardiac conditions—can increase the likelihood of an ADE. Similarly, certain events such as myocardial infarction, or conditions such as cardiac arrhythmias or atrial fibrillation can also increase the complexity and number of prescription medications, thereby potentially making it less likely the patient will be able to independently use their medications correctly. In addition, a chronic health condition itself (e.g.,

having hypertension, coronary artery disease, congestive heart failure, chronic kidney disease) may make a patient more at risk for experiencing medication-related complications following a care transition. While these conditions are not directly on the path to re-hospitalization, they can influence the outcome of interest through the complexity of the medication regimen and the number of medications a patient must take.

Figure 2-3: Patient-level Factors



Patient demographic and patient enabling factors can also serve as mediators and moderators on the path shown above. These could include age, which can proxy for health status (i.e., being of older age can increase the likelihood of having chronic conditions that fall within either of these streams). Gender can affect these streams in that it proxies for genetic differences in disease, differences in recommended care, and cultural norms (e.g., males may be less inclined to seek care). Race/ethnicity has been shown in past studies to be associated with a variety of patient outcomes, though the exact basis for that has not been fully established. Possible factors may include differences in socioeconomic status, environmental deprivation, education, access to care, cultural beliefs, social support systems, and health literacy.

Other patient enabling factors include improved access to care, so that patients can more readily present to ambulatory settings before medication-related symptoms or complications become so severe that they require emergency treatment, and where patients can receive education about medication self-management strategies; insurance status, where having insurance can moderate the underlying health and conditions of a patient by allowing for access when needed; primary language and health literacy, where if a patient does not understand the language of or recommendations from his or her provider, it may be difficult to follow a prescribed regimen; and socioeconomic status, where if a patient lacks the resources for care or basic necessities such as food, medications may go unfilled and make self-management more difficult. Finally, marital status and social support also play an important role in medication adherence. Having a spouse, partner, or caregiver that lives with the patient can affect a patient's ability to adhere to medications, seek care when needed, and provide encouragement and reinforcement around self-management.

The MyMEDS interventions are intended to address the factors described in this conceptual model with the goal of improving medication list accuracy and patient adherence. MyMEDS specifically aimed to augment both provider-level and mutable patient-level factors and leverage existing health system-level factors, which in-turn influence the patient-level factors that are hypothesized to affect this pathway.

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Chapter III. Transitional care between hospital and home: Using health coaches and primary care-based clinical pharmacists to reduce medication errors, improve medication management, and reduce utilization

3.1 Abstract

Background/Objectives: For older patients who are discharged to home following acute hospitalization, medication-related errors and medication non-adherence are common and can contribute to drug-related complications and subsequent inpatient utilization. The objective of this study was to evaluate the impact of a hospital to home care transitions program focused on identifying and correcting medication-related problems through a home visit that used a health coach in partnership with a clinical pharmacist who was embedded in the primary care clinics of a large, academic community-based primary care network.

Intervention: This intervention was a partnership between UCLA Health and Partners in Care Foundation (PICF)—a non-profit community health organization. A health coach from PICF visited a patient's home 11 days, on average, after the patient was discharged from the hospital, and took an inventory of all medications in a patient's home through conversation with the patient, caregiver (if present), and direct observation of places in the patient's home where medications are likely to be stored. Patients and their caregivers were asked about which medications were currently being used and how each was being taken. During the home visit, the health coach constructed a list of current medications on a standardized template on a tablet computer and electronically transmitted this to a UCLA clinical pharmacists who reviewed and reconciled the list from the home against the patient's electronic medical record (EMR) medication list. The clinical pharmacist identified areas of potential problems (e.g., discrepancies in the medication lists, patients taking medications differently than prescribed, duplicate prescriptions that were not recognized as the same medication). They documented and

communicated their findings to the patient's primary care physician (PCP) via the EMR's electronic in-basket and/or via phone calls if the problems identified were deemed to be potentially life threatening. This intervention was a modification of the nationally-tested HomeMeds program, the Coleman Care Transitions Intervention, and the UCLA Health MyMEDS program.

Study participants: Participants included adult patients over the age of 65 who were admitted to UCLA Health's Ronald Reagan hospital for a non-elective admission during the study period, and met the study inclusion criteria. The study sample consisted of 494 patients who received the intervention and 2,470 matched-control group patients.

Study Enrollment Period: July 1, 2014 to December 31, 2016

Study Design: Retrospective observational study with a propensity-score matched control group

Methods: We derived a control group by first applying the HomeMeds intervention inclusion and exclusion criteria to all patients who were discharged from a UCLA hospital to home during the study period. We then used a 5:1 propensity score match and multivariate logistic regression models to determine the impact of the intervention on the outcomes of interest. Characteristics that were matched upon included gender, race, age, hypertension, coronary artery disease (CAD), mental health diagnosis, dementia, congestive heart failure (CHF), atrial fibrillation, acute kidney injury (AKI), stroke, peripheral vascular disease, diabetes, schizophrenia, depression, mild cognitive impairment (MCI), use of warfarin, total number of medications, number of hospital visits in year prior to index visit, whether or not the patient had a hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization

admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization.

Outcomes of Interest: 30, 60, and 90-day hospital readmissions and 30-day emergency department utilization (ED visits).

Results: In a multivariate logistic regression model that used a matched-control group and adjusted for patient-level demographic and clinical covariates, participation in the program was associated with significantly lower predicted probabilities of being readmitted after 30 days (10.6% for HomeMeds versus 21.4 % for control, p-value <0.001), 60 days (21.8 % for intervention versus 28.8% for control, p-value <0.001), and 90 days (29.9% for intervention versus 34.0% for control, p-value <0.001), as well as a significantly lower predicted probability of having an unplanned ED visit within 30 days (10.4% for intervention versus 18.9% for control, p-value <0.001).

Conclusion: This home-based health coach and clinical pharmacist intervention that aimed to reduce utilization following care transitions from acute hospitalization to home was associated with significantly lower predicted probabilities for experiencing all outcomes included in our study: 30, 60, and 90-day hospital readmissions, and 30-day ED visits.

3.2 Introduction

Improving care transitions—the movement of patients across care settings—is of high priority for health systems and policy makers. Among the Medicare population, approximately 20% of hospitalized patients are readmitted within 30 days, and 34% of hospitalized patients are readmitted within 90 days (1). The cost of poorly organized care transitions is substantial, with estimates ranging from $12 billion to $44 billion annually (2). Among the most common reasons for readmissions following care transitions are adverse events such as infections, medication complications, or falls (3).

Medication-related problems are common among individuals who are over the age of 65 years due to reasons such as altered pharmacokinetics and because older patients tend to be prescribed a higher number of medications compared with younger patients. Nearly 60% of adults over the age of 65 take between five and nine medications daily, and nearly 20% take 10 or more medications daily (4, 5). Medication-related problems are accentuated during care transitions because medication intake is often not accurate, and medication regimens often change during acute hospitalization (6). Changes in medication regimens can lead to documentation errors, confusion, and medication misuse among patients (7-12), all of which can contribute to adverse drug events, and hospital readmissions (13). Forester et al. (2003) estimated that 72% of the adverse events that occur following discharge from the hospital are related to medications, which affects between 12% and 17% of patients after discharge from the hospital. Approximately half of these result in subsequent inpatient utilization (10).

Given the observed association between care transitions, medication complications, and readmissions among the Medicare population, identifying ways to improve medication accuracy and adherence so as to reduce preventable medication-related problems has been recognized as a

research priority and an important component of discharge efforts and care transition programs (14-16). The most widely adopted comprehensive care transition programs that employ multidisciplinary care teams (e.g., Care Transitions Intervention, Transitional Care Model, Project Re-Engineered) include some focus on medication management or medication reconciliation, as well as a home visit during which medications may be discussed. The results of these care transition programs have been overwhelmingly positive, with evaluations of each showing a reduction in hospital readmissions as well as costs (17-21).

In the care transitions literature, less is known about the impact of clinical pharmacist-anchored interventions that focus specifically on medication accuracy and medication management, and that are integrated with or rooted in the patient's primary care setting (22). For health systems or providers that may not have the capacity to launch the comprehensive and resource-intensive care transition programs, it is important to investigate which components of these models might be independently effective in improving patient outcomes and achieving desired utilization outcomes. The present study evaluates a care transitions intervention where the goal was to reduce medication-related problems among older, high-risk Medicare patients following acute hospitalization. The intervention included one home visit made by a health coach followed by review of medications by a clinical pharmacist who was embedded in the primary care clinics of a large, academic, community-based health system. Our hypothesis was that patients who received the program would have a lower predicted probability of re-hospitalization and unplanned emergency department (ED) visits than similar patients who received usual care. We hypothesized that this difference would be attributable to improved medication accuracy and medication management for the patients in the program.

3.3 Methods

Study Setting and Study Period

This program took place at UCLA Health, Partners in Care Foundation (PICF), and the greater Los Angeles community. UCLA Health is a comprehensive healthcare system with two hospitals and 33 primary care clinics. PICF is a not-for-profit community-based organization located in Los Angeles County. For over 20 years, PICF has been developing and spreading high-value models of community-based care and self-management for home-bound elderly patients. The intervention study period spanned two and a half years from July 1, 2014 to December 31, 2016.

The study was approved by the institutional review board of the University of California, Los Angeles (UCLA). Funding for the intervention was provided by the Centers for Medicare and Medicaid (CMS) Innovation Models, specifically a Community-Based Care Transitions Program (CTTP). Funding was also provided by the UCLA Resource Centers for Minority Ageing and Research, Center for Health Improvement of Minority Elderly under National Institutes of Health (NIH)/NIA grant P30-AG021684, the NIH/National Center for Advancing Translational Sciences UCLA Clinical and Translational Science Institute Grant Number UL1TR000124, and California Delivery System Reform Incentive Pool (DSRIP) funding.

The HomeMeds Program: A nationally-tested, evidence-based intervention

HomeMeds is an evidence-based program that was developed in the 1990s at Vanderbilt University with the goal of preventing hospitalizations by using community-based organizations to conduct home visits to reduce medication problems for vulnerable, older adults. The original

program sought to address the following common, high-risk problems in older, home-bound adults through home visits by health coaches in partnership with clinical pharmacists:

1) Unnecessary therapeutic duplication
2) Psychotropic drug use in patients with a reported recent fall and/or confusion
3) Non-steroidal anti-inflammatory drug (NSAID) used in patients at high risk of peptic ulcer complications
4) Cardiovascular medication problems—high blood pressure, low pulse, orthostasis and low systolic BP

Adaptation of the HomeMeds Program for Implementation and Evaluation

UCLA Health and PICF formed in a partnership in 2014 to launch a program that used the core features of the national HomeMeds program, the Coleman Care Transitions Intervention (CTI) and the UCLA Health Managing your Medications for Education and Daily Support (MyMEDS). CTI is a comprehensive care transitions intervention that aims to improve outcomes for patients transitioning between the hospital and home. The model includes four pillars: Medication Self-management, Patient-Centered Record, Follow-up, and Red Flags. The PICF HomeMeds program was a modification of CTI that focused on the first of the four pillars—addressing medication-related problems. MyMEDS is a program at UCLA Health that was initiated in 2012 and embeds clinical pharmacists in primary care clinics with the goal of improving medication management and patient adherence.

Intervention Protocol

Eligible patients were identified by UCLA Health hospital staff and study coordinators while in the hospital. The ambulatory team referred patients by reviewing daily admissions and determining who met the study criteria. Care managers and nurses also had the ability to refer based on their observations. To invite eligible patients to participate in the study, a research coordinator visited the patient at the bedside to describe the program. If the patient agreed to

participate, the research assistant sent notification to PICF with the patient's contact information. The PICF health coach then visited the patient at bedside to explain the services and obtain verbal consent, and also introduced the patient to the Personal Health Record—a feature of the CTI intervention.

Inclusion and Exclusion Criteria

Study inclusion criteria included hospitalization for a non-elective reason at UCLA Ronald Reagan Medical Center during the study period, having an assigned UCLA PCP, having Medicare fee-for-service (FFS) insurance, being discharged to home, and having two or more of the risk factors listed below:

- Readmission within last 30 days, and/or two or more admissions within last 12 months
- Hospital length of stay greater than 10 days
- Eight or more outpatient medications and/or outpatient medication adjustment of two or more medications at discharge
- Limited care giver support*
- Depression as secondary diagnosis
- Mild cognitive impairment as a secondary diagnosis
- Two or more chronic conditions

*This was determined by the referring source at the hospital, most likely a care manager (CM). For example, a CM working with the patient may be made aware that a patient did not have a strong support system in place.

Patients were ineligible for the intervention if they were homeless; sent to hospice on the day of discharge; in observation unit status; had a primary admission diagnosis of mental disease and/or substance abuse; or were admitted for scheduled or recurring chemotherapy, immunotherapy, radiation therapy, rehabilitation, or dialysis.

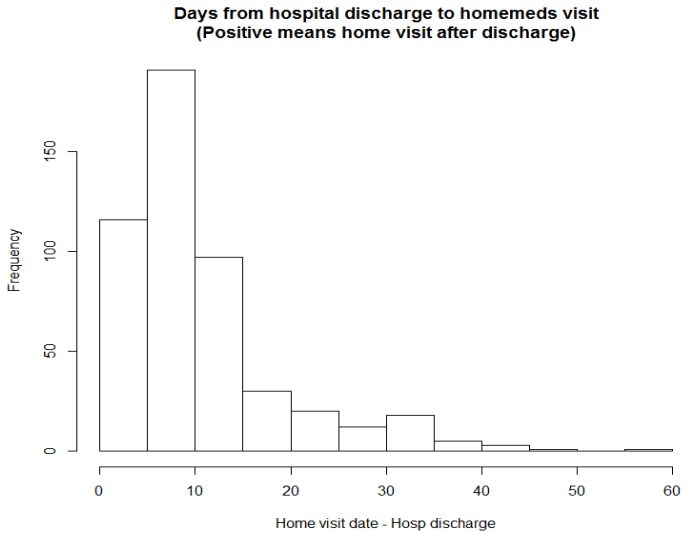
Health Coach Background and Training

The typical educational background for health coaches was a bachelor's degree in social work, gerontology, public health, or other related field. Health coaches were trained in CTI

training from Dr. Eric Coleman's team. This included training on all four pillars of the model. There were between 8 and 10 health coaches who conducted home visits as part of this intervention. During the home visit, health coaches followed the home visit protocol outlined in the CTI model. This included conducting a review of medications, and documenting any patient self-reported incidents (e.g., falls), health-related habits, symptoms, and vital signs. The health coaches recorded all medications prescribed and all over-the-counter (OTC) medications or supplements; interviewed patients and their care givers and recorded how medications were actually being used; worked with patients to set a personal goal; and engaged in role playing to promote patient self-management. The health coach also left materials about urgent care or providers to contact if the patient's condition worsened and also worked with the patient to complete the PHR, which included a problem list, medications, and questions for clinicians.

The home visit typically lasted 1.5-2 hours. Follow-up phone calls were also made by the health coach—3 phone calls at 7, 14, and 30 days after the home visit. Health coaches also assisted patients in scheduling follow-up appointments. On average, the home visits occurred 11 days after a patient was discharged, and 94 percent of the home visits occurred within 30 days of a patient's discharge from the hospital. The figure below shows the distribution of when the home visit occurred after a patient was discharged from the hospital.

Figure 3-1: Days between a Patient's Hospital Discharge and Home Visit by Health Coach



To document and communicate findings, the health coaches used a wireless tablet computer with a structured template during the home visit. In rare cases, they documented findings using paper and pencil. The medication form that the health coach used to inventory and document findings is included in the Appendix. The information collected by the health coach was electronically transmitted to UCLA clinical pharmacists who had full access to the UCLA Health EMR. The clinical pharmacist conducted medication reconciliation, and also had the ability to review the list of medications for unnecessary and potentially dangerous medications (e.g., Beers Criteria, duplicates, and drug-drug interactions). To document problem areas or discrepancies, the clinical pharmacists used a detailed template, which they used to communicate 1) with the patient if there were any items that were unclear, and 2) with the patient's PCP via the EPIC in-basket and with a copy in the provider notes section of the EMR. An example template used by the clinical pharmacists is included in the Appendix.

The clinical pharmacists completed their medication review immediately after the home visit occurred and before the patient visited their PCP following hospitalization so that the

physician could address any medication issues with the patient at that time. The clinical pharmacists made a set of recommendations to the PCP via the in-basket with suggested changes to improve the safety and effectiveness of the medications and, with PCP approval, implemented all of the changes in real time. The evaluation note then became a part of the medical record for the patient and remained in the EMR where all of the progress notes created by all providers are stored. The clinical pharmacists also called doctors for anything serious (e.g., harmful drug-drug interaction) so that changes could be made immediately rather than waiting for the patient's next visit.

The main difference and hypothesized advantage of this program compared with other care transition programs that focus on medication management is that it linked the health coach to clinical pharmacists who were embedded in the UCLA primary care practices and leveraged the UCLA Health IT infrastructure for medication reconciliation against the medication list in the EMR that is seen and used at every encounter in the health system. The program also utilized the communication tools (i.e., EPIC in-basket) to transmit the clinical pharmacist's recommendations in an efficient and timely manner to the patient's PCP so that problems could be addressed and resolved before they led to ED use and/or re-hospitalizations.

Intervention Patients

A total of 852 home visits were conducted during the study period. Patients who were hospitalized more than once during the study period were eligible for the intervention each time they were hospitalized. For patients who received the intervention more than once during the study period, we included only the first intervention date as part of the study. In total, 808 unique patients received the intervention. For the analysis, we excluded patients who received the intervention if they had no record in the EMR (n=5), if their admission was coded as elective

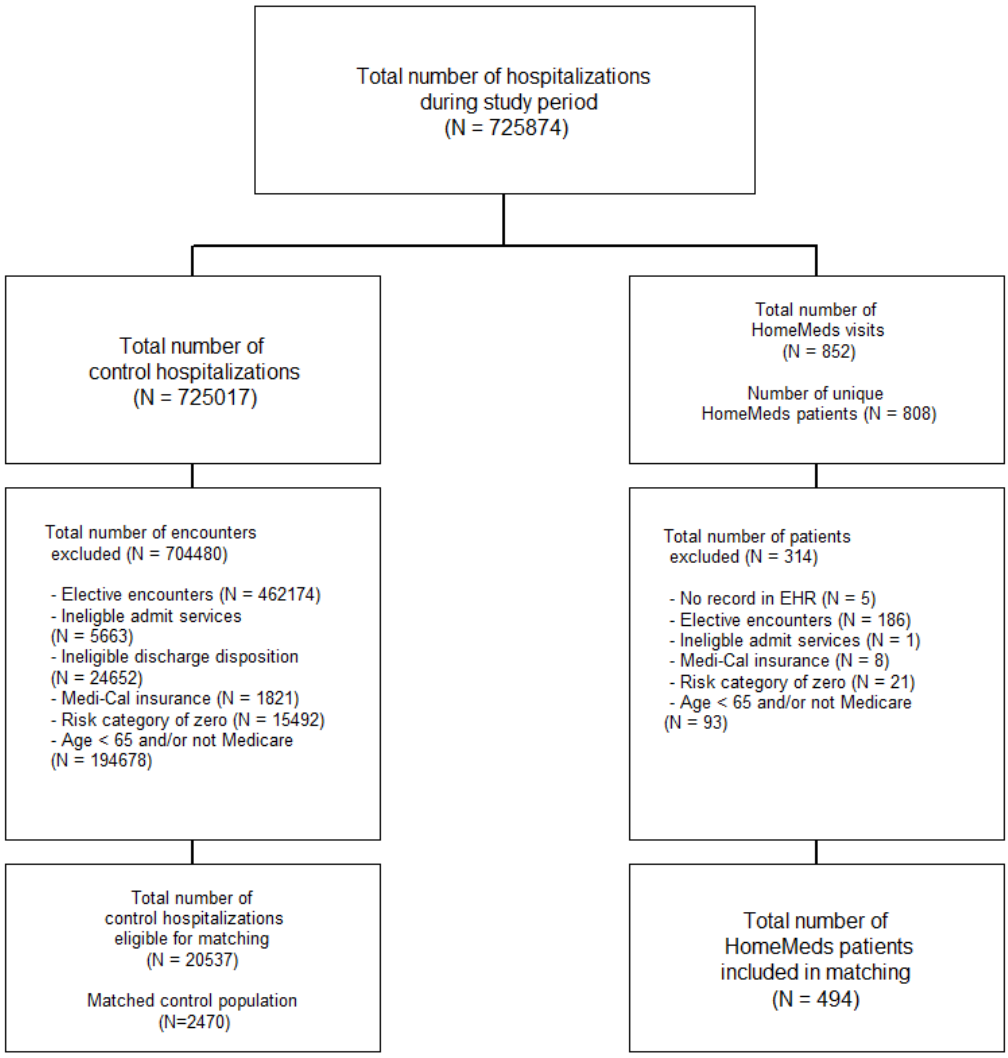
(n=186), if they had an ineligible admit service (n=1), if they had Medi-Cal insurance (n=8), if they did not have at least one risk factor listed above (n=21), and if they were under the age of 65 and/or did not have Medicare FFS as their primary form of insurance (n=93). After removing these patients, 494 patients were included in intervention arm of the program.

Control population

As this study was not randomized, we derived a control population by applying the study inclusion and exclusion criteria to all patients admitted to UCLA Ronald Reagan hospital during the study period (n=725,874). After restricting the control population based on the inclusion and exclusion criteria, the total number of hospitalizations (i.e., one patient could be hospitalized numerous times) during the study period decreased to n=20,537. In order to obtain a control group that was at the patient level as opposed to the encounter level, and achieve better balance between the demographic and clinical characteristics of the intervention and control groups, we used a propensity score matching approach. Propensity score matching is a statistical technique used to achieve better balance between intervention and control groups in non-randomized studies. We selected variables for the match that we determined were likely to influence receiving the intervention. These included gender, race, age, presence of hypertension, coronary artery disease (CAD), mental health diagnosis, dementia, congestive heart failure (CHF), atrial fibrillation, acute kidney injury (AKI), stroke, peripheral vascular disease (PVD), diabetes, schizophrenia, depression, mild cognitive impairment (MCI), use of warfarin, total number of prescription medications, number of hospital visits in the year prior to index visit, whether or not the patient had a hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization.

We then used logistic regression models to obtain the predicted probability of receiving the intervention (i.e., propensity score) for each patient. We used an approach similar to a Greedy Search Algorithm (23) to conduct the match. With this approach, a distance matrix was created where intervention patients comprised rows and control patients comprised the columns. Patients were then matched based on the smallest distance between propensity scores. Five control patients were matched to each intervention patient. If there were ties between propensity scores, one patient was randomly selected for the match. After a control patient was matched, the patient was removed from the sample. For balancing diagnostics, we observed the clinically significant and statistically significant differences between intervention and matched control patients, as well as graphical box plots of the overlap of propensities for the full control sample, matched control, and intervention patients (see Appendix).

Figure 3-2: Study Flow Diagram, HomeMeds



Statistical Analysis

Using a propensity score-matched control group, we used multivariate logistic regression models to determine the impact of the intervention on the outcomes of interest. We compared baseline demographic and clinical characteristics of the intervention and control groups using Wilcoxan Rank Sum test for continuous variables and Fisher's Exact tests for categorical variables. For the main model results, we present predictive probabilities for intervention versus

control patients for our outcomes of interests. Odds ratios and the full regression model are presented in the Appendix.

Primary Outcome Measures and Covariates

Our primary outcome measures are 30, 60, and 90-day non-elective hospital readmissions, and 30-day unplanned ED visits. All data were obtained from UCLA Health administrative data. Our primary predictor was whether or not a patient received the intervention—coded as a dichotomous variable where 1 indicated receiving the intervention and 0 indicated not receiving the internveiton. For model covariates used in the multivariate logistic regression, we selected variables using bivariate analyses of the individual predictors and the outcome of interest. Variables that were significant below an alpha of 0.2 were included. We used this data-driven approach for covariate selection because while there is ample literature that explores predictors of hospital readmissions, these studies typically focus on a particular patient population (e.g., patients with heart failure or diabetes). As our study population was heterogeneous, and given that we were considering 30, 60, and 90-day readmissions where the predictors of readmission might vary across time periods, we determined this variable selection approach would better allow us to obtain an unbiased estimate of the treatment effect. We did not include medications in the model because medications were subject to the intervention (i.e., the intervention was intended to influence the drugs a patient was taking). Finally, we evaluated the predictive power and specification of the model by observing the area under the curve (receiver operating curve).

Several variables were derived for this analysis. In order to apply the inclusion criteria to the control patients, we created a risk factor count variable. Specifically, a patient was assigned one point for each of the following, for a maximum score of 6:

- Hospitalization 30 days prior to index or >=2 hospitalizations in the year prior to index
- Length of stay (LOS) of hospitalization > 10 days
- Number of medications >= 8
- Depression
- Mild cognitive impairment (MCI)
- Two or more chronic conditions, which include hypertension, coronary artery disease, congestive heart failure, atrial fibrillation, acute kidney infection, stroke, peripheral vascular disease, diabetes, schizophrenia

Comorbidity variables were derived by using the patient's problem list as documented in the EMR, and ICD-9 codes (24). We used a window of one year prior to the intervention date to one month after the intervention date.

Stata (IC-12; StataCorp LP, College Park, TX, USA) and R (R Core Team, Vienna, Austria) were used to conduct the statistical analyses.

3.4 Results

Our study sample included 494 intervention patients and 2,470 matched-control patients. Table 1 shows descriptive statistics for the intervention and matched control patients. The baseline characteristics show that this study population was comprised of older, vulnerable patients who had high inpatient utilization in the period preceding this intervention. After the propensity score matching, baseline characteristics were similar among intervention and control patients with regard to gender (62.1% versus 62.4% p-value=0.919), age (83.0 versus 82.7, p-value=0.476), race-White (66.0% vs. 67.8%, p-value=0.461), race-Black (15.2% versus 13.4%, p-value=0.316), race-Asian (7.5% versus 7.0%, p-value=0.701), ethnicity-Hispanic (14.0% versus 12.9%, p-value=0.512), primary language-English (86.0% vs. 82.8%, p-value=0.085), partnership status-Married/Partner (43.9% vs. 44.6%, p-value=0.804). Intervention and control patients were also similar with regard to their diagnosis of comorbidities. In particular, patients in both groups did not show statistically or clinically significant differences in having

hypertension (57.5% versus 55.4%, p-value=0.399), CAD (23.5% versus 21.0%, p-value=0.23), mental health diagnosis (16.0% versus 14.4%, p-value=0.366), dementia (10.3% versus 8.9%, p-value=0.304), and diabetes (21.1% vs. 20.2%, p=0.669).

Variables that remained statistically significant at p<.05 after the propensity score match included experiencing between one and five hospitalizations in the 12 months prior to the intervention date (51.2% for intervention patients versus 48.0% for control patients, p=0.047); experiencing between one and five unplanned ED visits in the 12 months prior to the intervention date (50.6% for intervention patients versus 46.1% for control patients, p=0.039), average number of medications a patient was taking (15.5 for intervention patients versus 14.0 for control patients, p=0.008), and count of risk factors a patient had (1 risk factor: 30.2% for intervention patients versus 41.7% for control patients; 2 risk factors: 41.1% for intervention patients versus 35.9% for control patients; 3 risk factors: 20% for intervention patients versus 17% for control patients; 4 risk factors: 8.1% for intervention patients versus 4.7% for control patients; 5 risk factors: 0.6% for intervention patients versus 0.5% for control patients; 6 or more risk factors: 0% for intervention patients and 0.1% for control patients, p<0.001.)

Unadjusted and Adjusted Outcomes

Table 2 shows the unadjusted outcomes of interest for intervention and matched-control patients. Intervention patients had a significantly lower unadjusted rate of 30-day hospital readmissions (11.1% vs. 21.2%, p-value<0.001), 60-day readmissions (22.9% vs. 28.6%, p-value<0.001), and 30-day unplanned ED visits (10.9% vs. 18.8%, p-value<0.001). The intervention and matched-control groups were not significantly different for 90-day readmissions (31.4% vs. 33.6%, p-value=0.347).

Table 3 shows the adjusted outcomes of interest—predicted probabilities for all outcomes of interest—for intervention and matched control patients. After adjusting for patient-level demographic and clinical covariates, patients who received the intervention had a significantly lower predicted probability for all outcomes. Patients who received the intervention had a 10.6% chance of being readmitted within 30 days while patients who did not receive the intervention had a 21.4% chance of being readmitted within 30 days (p-value<0.001), all other variables in the model held constant. Patients who received the intervention had a 21.8% chance of being readmitted within 60 days while patients who did not receive the intervention had a 28.8% chance of being readmitted within 60 days (p-value<0.001), all other variables in the model held constant. Patients who received the intervention had a 29.9% chance of being readmitted within 90 days while patients who received usual care had a 34.0% chance of being readmitted within 90 days (p-value<0.001), all other variables in the model held constant. Patients who received the intervention had a 10.4% chance of experiencing an unplanned ED visit within 30 days of discharge while patients who received usual care had a 18.9% chance of an unplanned ED visits (p-value <0.001), all other variables in the model held constant. Interactions between the intervention and age groups (i.e., investigating whether the oldest old benefited more from this intervention), as well as interactions between the intervention and race were not significant.

Table 3-1. Baseline Characteristics, Intervention and Matched Control Patients

Variable	HomeMeds (n = 494)	Control (n = 2470)	p-value
Female	307 (62.1%)	1541 (62.4%)	0.919
Race			
White	326 (66%)	1674 (67.8%)	0.461
Black	75 (15.2%)	332 (13.4%)	0.316
Asian	37 (7.5%)	173 (7%)	0.701
Other/Unknown	56 (11.3%)	291 (11.8%)	0.818
Ethnicity - Hispanic	69 (14%)	319 (12.9%)	0.512
Age - categorical			0.166
65-74	112 (22.7%)	630 (25.5%)	

74-84	155 (31.4%)	814 (33%)	
>=85	227 (46%)	1026 (41.5%)	
Primary Language - English	425 (86%)	2045 (82.8%)	0.085
Partnership Status - Married/Partner	217 (43.9%)	1102 (44.6%)	0.804
Comorbidities			
Hypertension	284 (57.5%)	1368 (55.4%)	0.399
Coronary artery disease	116 (23.5%)	519 (21%)	0.23
Mental Health diagnosis	79 (16%)	356 (14.4%)	0.366
Dementia	51 (10.3%)	219 (8.9%)	0.304
Congested heart failure	98 (19.8%)	462 (18.7%)	0.571
Atrial fibrillation	159 (32.2%)	784 (31.7%)	0.874
Acute kidney injury	99 (20%)	410 (16.6%)	0.067
Stroke	69 (14%)	336 (13.6%)	0.83
Pulmonary vascular disease	30 (6.1%)	131 (5.3%)	0.514
Diabetes Mellitus	104 (21.1%)	500 (20.2%)	0.669
Schizophrenia	8 (1.6%)	36 (1.5%)	0.838
Mild cognitive impairment	33 (6.7%)	146 (5.9%)	0.534
Number of medications	15.5 (10-21)	14 (7-22)	0.008
Hospital Visits 1 year prior to index visit			0.047
0	224 (45.3%)	1235 (50%)	
1-5	253 (51.2%)	1185 (48%)	
>5	17 (3.4%)	50 (2%)	
Any hospital visit 30 day prior to index visit	104 (21.1%)	443 (17.9%)	0.112
ED Visits 1 year prior to index visit			0.039
0	231 (46.8%)	1292 (52.3%)	
1-5	250 (50.6%)	1138 (46.1%)	
>5	13 (2.6%)	40 (1.6%)	
Length of stay of index visit, mean (SD)	4.2 (4.4)	4.1 (8)	NC
Index discharge on a weekend	75 (15.2%)	614 (24.9%)	<0.001
Count of risk factors			<0.001
1	149 (30.2%)	1031 (41.7%)	
2	203 (41.1%)	887 (35.9%)	
3	99 (20%)	420 (17%)	
4	40 (8.1%)	117 (4.7%)	
5	3 (0.6%)	13 (0.5%)	
6	0 (0%)	2 (0.1%)	

* Matched ratio of 5-to-1 on the following variables: Gender, race, age, hypertension, coronary artery disease, mental health diagnosis, dementia, congestive heart failure, atrial fibrillation, acute kidney injury, stroke, peripheral vascular disease, diabetes, schizophrenia, mild cognitive impairment, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not the patient had a hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization.

Table 3-2: Unadjusted Outcome Model, Intervention and Matched Control Patients

	Intervention	**Matched Control**	**P-value**
30-day hospital readmission	55 (11.1%)	524 (21.2%)	<0.001
60-day hospital readmission	113 (22.9%	706 (28.6%)	0.010
90-day hospital readmission	155 (31.4%)	830 (33.6%)	0.347
30-day ED visit	54 (10.9%)	464 (18.8%)	<0.001

Table 3-3: Adjusted Outcome Model

	Predicted Probability		P-value
	Intervention (95% CI)	**Matched Control (95% CI)**	
Adjusted 30-day hospital readmission*	10.6 (7.9-13.2)	21.4 (19.8-23.0)	<0.001
Adjusted 60-day hospital readmission**	21.8 (18.3-25.3)	28.8 (27.1-30.6)	<0.001
Adjusted 90-day hospital readmission***	29.9 (26.0-33.8)	34.0 (32.1-35.7)	<0.001
Adjusted 30-day ED visit****	10.4 (7.8-13.0)	18.9 (17.4-20.5)	<0.001

*Control variables include: Female, ethnicity-Hispanic, hypertension, coronary artery disease, mental health diagnosis, dementia, congestive heart failure, atrial fibrillation, stroke, schizophrenia, depression, mild cognitive impairment, hospital visit 1 year prior, ED visit 30 days prior, and count of risk factors.
**Control variables include: Female, ethnicity-Hispanic, age, hypertension, coronary artery disease, mental health diagnosis, dementia, congestive heart failure, atrial fibrillation, acute kidney injury, stroke, diabetes, schizophrenia, depression, mild cognitive impairment, number of medications, hospital visits 1 year prior, hospital visit 30 days prior, and count of risk factors.
***Control variables include: Female, ethnicity-Hispanic, age, primary language-English, partnership status-married/partner, hypertension, coronary artery disease, mental health dx, dementia, congestive heart failure, , atrial fibrillation, acute kidney injury, stroke, peripheral vascular disease, diabetes, schizophrenia, depression, mild cognitive impairment, hospital visit 1 year prior, hospital visit 30 days prior, ED visit 1 year prior, and count of risk factors.
****Control variables include: Female, ethnicity-Hispanic, age, partnership status-married/partner, hypertension, coronary artery disease, mental health diagnosis, dementia, congestive heart failure, atrial fibrillation, acute kidney injury, stroke, peripheral vascular disease, diabetes, schizophrenia, depression, mild cognitive impairment, hospital visit 1 year prior, hospital visit 30 days prior, and count of risk factors.

3.5 Discussion

We found that this home-based, health coach and clinical pharmacist-driven intervention for older patients transitioning from acute hospitalization to home was associated with significantly lower predicted probabilities of being readmitted after 30, 60, and 90 days, and was also associated with a significantly lower predicted probability of having an unplanned ED visit within 30 days. Our results demonstrate that a medication-focused intervention can be effective in preventing readmissions in the short, intermediate, and the long-term. Considering not just 30-day readmissions, but also 60 and 90-day readmissions can be important in the context of medication events that require re-hospitalization because, as has been noted in previous studies

(22), medication discrepancies resulting from a care transition (e.g., inadvertent discontinuation of anticoagulants or cholesterol medications) and complications that follow may require hospitalization, but not necessarily within 30 days.

To our knowledge, this is the first evaluation of a care transitions program that modified the HomeMeds and CTI models and utilized clinical pharmacists who were embedded in primary care practices in a non-integrated system. This allowed for taking advantage of features of the EMR to ensure that, after a medication concern or harmful medication problem was recognized, information was quickly transmitted to the PCP who could take action in a timely manner before serious health problems developed (e.g., medical decompensation requiring readmission or ED use). Embedding clinical pharmacists in the primary care team where they have full access to the EMR can provide the crucially-needed bridge between care at home and care in the health system. Improving the linkage between the hospital, home, and primary care following a care transition has been identified as an important component of the care transition process that is often lacking (25).

This intervention reflects a modification of the first pillar outlined by Coleman's CTI model, which focuses on medication self-management. While we recognize that medication-related problems are not the only contributors to subsequent utilization as indicated by the other pillars that address the patient-centered record, follow-up, and red flags, our findings suggest that this first pillar is potentially a very important one in influencing utilization. The positive results we observed could inform how to effectively achieve the goals of Pillar 1, which is "patient is knowledgeable about medications and has medication management system." This collaborative approach between a health coach and a clinical pharmacist who can make rapid and effective changes by communicating with a patient's PCP may have advantages over other approaches in

addressing medication challenges. It is important to note that the embedded clinical pharmacists involved in this intervention mainly conducted ambulatory visits with the most complex patients in these practices. The clinical pharmacist's participation usually constituted less than 10% of their work week. This program also leveraged an existing infrastructure and was built atop of an already functioning collaboration between PCPs and clinical pharmacists designed to improve medication management.

Methodologically, our study advances the current care transitions literature by testing this intervention in a large, non-integrated, geographically dispersed academic primary care network and by using a matched-control group. Most published studies that evaluate these models have been single site RCTs with limited sample size. The retrospective observational design of our evaluation and the specific focus on medication management potentially increases the external validity of this study.

Compared with comprehensive care transition studies that use multiple care team members and include numerous components, we found that this program was associated with a reduction in readmissions that is similar to the findings that have been observed in the more comprehensive and complex transitions of care interventions reported in the literature. Evaluations of Project RED have shown that the program was associated with a 30% reduction when using a combined measure of hospital readmissions and ED visits (17). A randomized control trial (RCT) evaluating Mary Naylor's Transitional Care Model showed that intervention patients had a lower likelihood of readmission at 24 weeks compared with control patients (20.3% vs. 37.1%). Using a cox proportional hazards model, they also found that intervention patients had a significantly longer time to first re-hospitalization (19). Evaluations of the Coleman CTI model showed significant effects on readmission rates in both the short and longer

term. An RCT found that the 30-day readmission rate for patients who received this intervention was 30% lower compared with patients who received usual care; at 180 days, the readmission rate for intervention patients was 17% lower compared with patients who received usual care (21). The heterogeneity in primary outcome measures and methods undertaken in these studies (e.g., composite measure for readmissions and ED visits, survival analysis that measured time to event) makes it difficult to draw exact comparisons to our findings. Broadly, though, the direction and magnitude of our results are similar to these previous care transition studies.

We believe that the larger effect size we observed versus that of the Coleman CTI evaluation could be due to differences in the baseline characteristics of the two study populations. Compared with the CTI study population, our intervention patients were older (83 vs. 76), more racially diverse (66% vs. 88% White), less likely to live with a spouse/partner (43.9% vs. 58.1%), and were more likely to have the following chronic conditions: diabetes (21.1% vs. 2.7%), congestive heart failure (19.8% vs. 16.5%), and stroke (14% vs. 2.4%).

In addition to the differences in the study populations, while the PICF program was a modification of the CTI model, it is important to note several differences between that program and the one evaluated here. First, the CTI model uses "advanced practice nurses" to carry out the program whereas we used health coaches and clinical pharmacists. Second, in the CTI model, the home visit following hospital discharge had to be conducted within 72 hours. In our program, the timing of the home visit was made after an average of 11 days. Third, while a major component of the CTI was to educate the patients and equip the patient with the PHR to promote ownership of their care, our program was designed so that the clinical pharmacist assumed most of that responsibility instead of putting the onus on the patient (e.g., communicating important

information directly with the patient's PCP and advising on items that should be discussed with the patient in the next visit).

Limitations

Our study has several limitations. First, this study was conducted at one large community-based academic primary care network in one urban area, and thus may not be generalizable to all settings and patient populations. Second, the study was not randomized. We therefore did not control for unobservable characteristics that could influence our primary outcome. Third, the health system data used do not allow us to know whether a patient was readmitted to a hospital outside of UCLA Health, but we suspect this occurred for both intervention and control patients and therefore should not necessarily bias the differences in utilization observed. And fourth, administrative data do not allow us to know the cause for readmission, and whether the differences we observed between the intervention and control groups were attributable to a reduction in medication-related problems.

Conclusion

This study demonstrates the potential benefits that health coaches and clinical pharmacists, who have a full view of the patient's medical history and medication list, can offer to patients who transition between acute hospitalization and home. Further study of this type of intervention in non-integrated health systems, and investigation of the potential cost savings, will be important for continuing to improve outcomes following care transitions.

3.6 References

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Chapter IV. Transitional care for patients between acute hospitalization and home: A qualitative review of medication problems identified and recommendations made by clinical pharmacists

4.1 Abstract

Background/Objectives: For older patients who are discharged to home following acute hospitalization, medication-related errors and medication non-adherence are common and can contribute to drug-related complications that require re-hospitalization. The objective of this study was to perform a qualitative review of charts for patients who were recently discharged from hospital to home to document the prevalence and types of medication-related problems (MRPs) that can occur following care transitions.

Intervention: This intervention was a partnership between UCLA Health and Partners in Care Foundation (PICF), a non-profit community health organization. A health coach from PICF visited a patient's home after the patient was discharged from the hospital. The health coach documented all medications in the home, along with signs and symptoms, through conversation with the patient and/or caregiver, and observation of the patient's home environment. This information was sent to UCLA clinical pharmacists who reviewed and reconciled the list using the UCLA electronic medical record (EMR). A clinical pharmacist identified areas of potential problems (e.g., discrepancies in the medication lists, patients taking medications differently than prescribed) and documented and communicated those findings to the patient's primary care physician (PCP). The clinical pharmacist had full access to a patient's home medication list, EMR medication list ("Care Connect"), and patient's health history, allowing for a comprehensive medication review.

Study participants: Participants included adult patients over the age of 65 who were admitted to a UCLA hospital for a non-elective reason during the study period, and met the study inclusion criteria. A total of 494 interventions were included in our study sample. For this qualitative study, the charts for 100 intervention patients were randomly selected and reviewed.

Study Period: July 1, 2014 to December 31, 2016

Study Design: This study employed a descriptive qualitative design using a coding scheme to document medication discrepancies and problems identified by a clinical pharmacist in reviewing patients' charts.

Methods and process measures: We randomly selected 100 patient charts, equally distributed by quarter throughout the study period. A template was developed that included 13 categories (e.g., therapeutic duplications, discrepancies between medication lists, medications not being taken as prescribed). Two independent reviewers used the template during the chart review to document findings. Results were compared between the reviewers, and discrepancies were discussed and resolved.

Results: In 98 out of 100 of the charts reviewed, the clinical pharmacist identified at least one medication-related issue. The most common issues identified by the clinical pharmacist were (1) discrepancies between the list of medications documented during the home visit compared with the patient's UCLA Care Connect EMR medication and supplement list (83/100); (2) pharmacists determined that patients were taking medications or supplements differently than prescribed (e.g., dose, timing) (52/100); and (3) recent dizziness or falls were reported by the patient, resulting in a recommendation for follow-up from provider (46/100).

Conclusions: This review of charts for patients who were discharged to home following acute hospitalization revealed substantial discrepancies in medication lists and potential medication-related problems that could contribute to future complications. The results of this study suggest that a clinical pharmacist who is embedded in the primary care setting with access to a patient's full medication list and medical history can serve an important role in mitigating potential medication problems following care transitions.

4.2 Introduction

Older patients are at increased risk for drug-related problems. They are more likely to be prescribed a high number of prescription medications, which increases the complexity of a medication list, the likelihood of drug-drug interactions, and non-adherence (1). These patients are also more likely to have multiple chronic conditions, which can impede the ability to self-manage medication regimens. Older patients are also more likely to have altered metabolism of medications, which can increase the risk of adverse drug events (2).

These drug-related problems common in older adults can be exacerbated during care transitions from one care setting to another (3, 4). Medication lists often change while a patient is hospitalized, which can lead to documentation errors or patient confusion about their medication regimen after discharge. In addition, providers are not always aware of a patient's full medical history and medications during hospitalization due to lack of interoperability, patients may not communicate complete and accurate information, and communication between hospital clinicians and the patient's primary care team after a patient is discharged may be insufficient (5). Ensuring optimal medication regimens during care transitions continues to be a focus among providers, payers, and policy makers.

Clinical pharmacists have been recognized as important members of multidisciplinary care teams (6), particularly in the context of care transitions (7). With their training in medication management, these providers are well-positioned to identify and resolve drug-related problems that contribute to adverse drug events. At UCLA Health, a program was tested over a two-and-a-half year period that aimed to reduce medication errors and improve medication management among patients who were discharged from the hospital to home. An evaluation of that intervention showed significantly lower predicted probabilities of being readmitted or having an

unplanned emergency department (ED) visit for patients who received the intervention compared with those who did not.

While several evaluations of hospital to home transitional care interventions that have incorporated clinical pharmacists have demonstrated positive results (e.g., significantly lower readmission rates and lower costs), these evaluations have generally measured utilization as the outcome measure of interest, which does not allow for understanding the specific mechanisms by which clinical pharmacists may positively influence patient outcomes and contribute to lower avoidable utilization (8-11). In addition, while there have been investigations of medication discrepancies at the time of hospital intake (12) and at the time of hospital discharge (13, 14), few have investigated discrepancies that persist in the weeks after a patient has returned home. The purpose of this study was to conduct a descriptive review of the prevalence and types of drug-related problems (DRPs) that clinical pharmacists identified among patients who received this care transition intervention, and what actions were taken to correct identified problems. Documenting the types and prevalence of DRPs for patients who transition between acute hospitalization and home can aid providers and health systems in effectively directing resources and strategies for patients undergoing care transitions.

4.3 Methods

The study undertaken is a qualitative investigation that follows the quantitative analysis presented in the previous chapter. For a complete description of the intervention protocol and patient inclusion and exclusion criteria, please refer to Chapter III.

Study population

A total of 494 patients who received the home visit and subsequent assessment by the clinical pharmacist were included in the intervention study arm. Among these intervention patients, 100 patient charts were randomly selected to review for this qualitative study. An equal number of charts were randomly selected for each quarter during the study period.

Template and coding scheme development process

This intervention combined elements and goals from both the existing PICF program and the UCLA Health MyMEDS program. As such, we drew from both in developing the template. For example, the PICF program focused on issues such as identification of drugs that contribute to dizziness and falls, and non-steroidal anti-inflammatory drugs (NSAIDS) that contribute to peptic ulcers or gastrointestinal (GI) bleeding. The MyMEDS intervention focused on issues such as unnecessary therapeutic duplication and patient adherence. Taking elements from both interventions, and with the additional opportunity to understand discrepancies between the medication lists patients used after discharge and the patient's medication list according to the EMR, we developed a template that included 13 categories.

The following categories were included in the template:

- Recommendations specific to Beers criteria medications in patients over 65
- Potential drug-drug interactions identified or drug-disease interactions identified
- Discrepancies between CareConnect and HomeMeds list
- Recent dizziness or falls reported by patient
- Increased confusion reported in last three months
- Polypharmacy/complex regimen simplification recommended
- Lab monitoring recommended
- Medications w/o refills, or medications expired
- Renal/hepatic dose adjustments recommended
- Use of NSAIDs and risk for gastrointestinal bleeding
- Patient taking medications differently than prescribed (e.g., dose, timing)

- Patient continuing to take medications that were discontinued by provider
- Unnecessary therapeutic duplications

Review process

Using the template above, we reviewed the clinical pharmacist's notes that were documented as part of the care transitions intervention. We reviewed 100 randomly selected patients from the intervention group (n=494). These were not the patient's full medical charts; rather, they were templates that the clinical pharmacists used to record medication-related concerns or problems after a patient was discharged and the home visit by the PICF health coach had been completed. Two independent reviewers used the template to review the documentation from the clinical pharmacists. Results from both reviewers were compared, and discrepancies were discussed and resolved. Each category in the template was marked with yes or no based on whether the clinical pharmacist had specifically highlighted and made actionable recommendations related to the problem. For example, in the case of the Beers category, a patient being prescribed a Beers medication did not necessarily warrant an affirmative response from the reviewer. Only if a pharmacist specifically indicated a problem, or potential problem, related to the medication and called for attention by the PCP did the reviewer report yes.

4.4 Results

Table 4-1: Baseline Characteristics for Study Population

Variable	HomeMeds (n = 494)	HomeMeds Chart Review (n=100)
Female	307 (62.1%)	67 (67%)
Race		
White	326 (66%)	69 (69%)
Black	75 (15.2%)	7 (7%)
Asian	37 (7.5%)	12 (12%)
Other/Unknown	56 (11.3%)	12 (12%)
Ethnicity - Hispanic	69 (14%)	12 (12%)
Age	83 (76-90)	82.6 (75-89)
Age - categorical		
65-74	112 (22.7%)	23 (23%)
74-84	155 (31.4%)	31 (31%)
>=85	227 (46%)	46 (46%)
Primary Language - English	425 (86%)	86 (86%)
Partnership Status - Married/Partner	217 (43.9%)	43 (43%)
Comorbidities		
Hypertension	284 (57.5%)	56 (56%)
Coronary artery disease	116 (23.5%)	21 (21%)
Mental Health diagnosis	79 (16%)	15 (15%)
Dementia	51 (10.3%)	10 (10%)
Congested heart failure	98 (19.8%)	13 (13%)
Atrial fibrillation	159 (32.2%)	33 (33%)
Acute kidney injury	99 (20%)	15 (15%)
Stroke	69 (14%)	18 (18%)
Pulmonary vascular disease	30 (6.1%)	8 (8%)
Diabetes Mellitus	104 (21.1%)	12 (12%)
Schizophrenia	8 (1.6%)	2 (2%)
Mild cognitive impairment	33 (6.7%)	10 (10%)
Number of medications	15.5 (10-21)	14.5 (9-20)
Hospital Visits 1 year prior to index visit		
0	224 (45.3%)	45 (45%)
1-5	253 (51.2%)	48 (48%)
>5	17 (3.4%)	7 (7%)
Any hospital visit 30 days prior to index visit	104 (21.1%)	20 (20%)
Hospitalization within 30 days of index visit	55 (11.1%)	7 (7%)
Hospitalization within 60 days of index visit	113 (22.9%)	17 (17%)
Hospitalization within 90 days of index visit	155 (31.4%)	27 (27%)
Length of stay of index hospitalization, mean (SD)	4.2 (4.4)	3.5 (4.96)

The majority of patients who received the HomeMeds intervention and were included in this chart review were more likely to be female (67%), and tended to be older—the average age among these patients who received the intervention was 82.62 (IQR 75-89) and 46% of the patients were over the age 85. The majority of the patients who received the intervention were

White (69%), while Black (7%), Asian (12%), and other/unknown (12%) comprised the rest of the population. The majority spoke English as their primary language (86%). Less than half were married or had a partner with whom they lived (43%).

Categories of medication problems	**Number of problems identified, n=100**	**Clinical Pharmacist Recommendations**
Discrepancies between Care Connect (EMR) and HomeMeds list	83	Resolve discrepancy and edit the record if needed.
Patient taking medications or differently than prescribed (e.g., dose, timing)	52	Recommend a visit to PCP or a phone call directly to the patient.
Recent dizziness upon standing or falls reported by patient resulting in recommendation for follow-up with PCP	46	Recommend PCP appointment for evaluation.
Recommendations were made by clinical pharmacists specific to modifying use of BEERS criteria medications	29	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.
Potential drug-drug interactions identified or drug-disease interactions identified	27	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.
Increased confusion reported by patient or caregiver in last three months resulting in recommendation for PCP evaluation	23	Recommend PCP appointment for further evaluation.
Polypharmacy/complex regimen simplification recommended	16	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.
Lab monitoring recommended	15	PharmD orders and reviews the lab results.
Medications w/o refills, or medications expired	11	Pharm D completed refills and helped patient with obtaining medications.
Renal/hepatic dose adjustments recommended	10	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.

Use of NSAIDs and risk for GI bleeding	9	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.
Patient continuing to take medications that were discontinued by provider	9	Recommend a visit to PCP or a phone directly to the patient.
Unnecessary therapeutic duplications	9	PharmD makes specific recommendations to PCP; if there is agreement, PharmD operationalizes these through the Epic in-basket.

With regard to comorbidities, over half of the patients included in this chart review had hypertension (56%), nearly a quarter had coronary artery disease (21%), and about one-fifth of the patients had congestive heart failure (19.8%) or acute kidney injury (AKI) (20%). A smaller percentage of patients had diabetes (12%), dementia (10%), mild cognitive impairment (10%), peripheral vascular disease (8%), or schizophrenia (2%). The average patient in this study population was taking 15.5 medications (IQR 10-21), and the average length of stay was 4.2 days (standard deviation 4.4). With respect to utilization in the year prior to this intervention, about half (48%) had been hospitalized one or more times, and 7% had been hospitalized on more than five occasions. Emergency department visits in the year prior showed a similar pattern: 51% had an unplanned ED visit one or more times, and only 6% had visited the ED on five or more occasions. These characteristics from the 100 randomly selected patients are similar to those of the original intervention group (n=494).

Table 4-2: Problems Identified and Actions Taken by Clinical Pharmacist

The review of 100 randomly selected patient charts revealed that the most common issue identified by the clinical pharmacists were discrepancies between Care Connect and the home visit medication list (83/100). The next most frequently identified issues were that patients were taking medications differently than prescribed (e.g., dose, timing) (52/100), recent dizziness or

falls in the past three months were reported during the home visit, resulting in recommendation for follow-up from PCP (46/100), recommendations were made by clinical pharmacists specific to Beers criteria medications (29/100), potential drug-drug interactions identified or drug-disease interactions were identified (27/100), and increased confusion was reported in last three months resulting in recommendation for PCP evaluation (23/100). Less commonly identified medication-related problems included polypharmacy/complex regimen simplification recommended (16/100), lab monitoring recommended (15/100), medications without refills or medications expired (11/100), use of NSAIDs and risk for serious peptic ulcer disease (9/100), patient continuing to take medications or supplements that were discontinued by provider (9/100), and unnecessary therapeutic duplications (9/100). With regard to the distribution of medication-related problems identified, we found that 2% of patients had 0 issues, 14% of patients had 1 problem, 21% of patients had 2 problems, 16% of patients had 3 problems, 21% of patients had 4 problems, 12% of patients had 5 problems, 8% of patients had 6 problems, 5% of patients had 7 problems, and 1% of patients had 8 problems.

Table 4-3: Distribution of Drug-related Problems, by Patient

Number of issues identified by clinical pharmacist	Number of patients
0	2
1	14
2	21
3	16
4	21
5	12
6	8
7	5
8	1

4.5 Discussion

In this study, we found that a clinical pharmacist identified at least one medication-related issue or concern for 98 out of 100 charts reviewed among patients who had recently undergone a care transition between the hospital and home. Our study contributes to the care transitions literature in that this is one of few studies that documents the prevalence and specific types of medication problems that can arise following care transitions. While there have been studies that investigate discrepancies at the time of discharge, few studies have investigated discrepancies that persist in days and weeks after a patient has been discharged from the hospital. In addition, no study to our knowledge has done so using multiple sources (i.e., home visit medication list and EMR) when conducting the medication review. Having access to these multiple sources of information captured during a home visit in combination with a patient's EMR that lists all medications allows for a more complete picture of the MRPs that may arise when a patient undergoes a transition from acute hospitalization to home.

Coleman (2005) conducted a similar study to that described here in that it followed an outcomes investigation of the Care Transition Intervention (CTI) model, and used the same patients who received the care transitions intervention (16). The study sought to describe the prevalence and types of drug-related problems that arise during care transitions between the hospital and home. There are important differences between our study and Coleman's. For example, in the Coleman study, the medication review was conducted by a nurse within 72 hours following hospitalization while ours was typically conducted two to four weeks after; the template used differed from ours; and the baseline characteristics of the study populations were different with regard to age (our patients were older), race/ethnicity (our patients were more racially/ethnically diverse), and discharge disposition (Coleman's study included patients

discharged to several settings while we only included patients who were discharged to home). Also, the Coleman study was completed more than ten years ago, which predated advances in the EMR that allowed the pharmacists in our intervention to complete a full, compressive review of patient's medications.

Despite these differences noted above, it is informative to compare findings from this previous study to ours for the categories in the template that overlapped. Their most common finding was that patients were non-adherent (33.9%). This was similar to our second most common finding that patients were taking medications differently than prescribed (52%). In the 2005 study, authors found that 8.1% of patients had duplications, which was similar to our finding that 9% had duplications. Our results differed in the prevalence of problems among patients, where they found that 14.1% of the patient charts had one or more discrepancies compared with 98% in our study. We suspect these differences could be due to the differences in templates used, different information used to inform the chart review, and differences in the patient populations.

Studies have found that certain medications are associated with hospital readmissions. Budnitz et al. (2011) found that warfarin, insulins, oral antiplatelet agents, oral hypoglycemic agents, opioids, digoxin, and Beers criteria medications are among the most common drugs associated with adverse drug events that lead to hospitalization (17). While some of the patients in our study were taking insulin and warfarin, the clinical pharmacists rarely made recommendations related to dosage changes because patients taking these medications tend to be treated frequently in specialized clinics. Digoxin, antiplatlets, opioids, other Beers drugs—especially benzodiazepines and hypnotics—were frequently noted by the clinical pharmacist and recommendations were made to reduce dosing or discontinue use. We hypothesize this also

contributed to the reduction in readmissions or ED visits that we observed among intervention patients.

The review of charts also revealed the important role that the clinical pharmacist played in coordinating with patients and care givers, and providing extra oversight more generally. For example, in several cases the notes described how the clinical pharmacist called the patient's caregiver to confirm that a patient was taking one or more drugs as directed, and recommended to the caregiver that doses be changed immediately. The clinical pharmacist's review also likely provided information to the PCP that made the in-person follow-up visit with the patient more productive, and may have helped patients who forgot to ask medication-specific questions or mention falls, dizziness, or confusion during the PCP visit. In the current climate of promoting patient self-management and empowering the patient to take on increasing responsibility for their care, this intervention shows that it may be beneficial to put the onus more on the side of the providers, especially for older, recently hospitalized, vulnerable patients.

Limitations

This study has several limitations. Frist, a discrepancy between Care Connect and EMR or problem identified was not necessarily clinically significant. This was a descriptive study that attempted to document what was found. Thus, we do not know the percentage of problems that were likely to cause serious harm or ADEs. Second, the template used here was created for this study, and therefore has not been validated. Third, this intervention was conducted in one large community based academic primary care network in one urban area, and results may therefore not be generalizable to other populations.

Conclusion

A wide range of medication discrepancies and MRPs can occur following care transitions. These problems can be attributed to system, provider, and patient-level factors. Despite widespread use of EMRs in recent years and increased attention around improving patient safety related to medications, medication lists still often have inaccuracies after a patient leaves the hospital. For older adults who take multiple medications, review of medications in the home setting and by a clinical pharmacist who is embedded in the patient's primary care setting can help to mitigate MRPs that could lead to more serious complications including adverse drug events and inpatient utilization.

4.6 Appendix, HomeMeds Evaluation

HomeMeds Formatting

Study window: 7/1/2014 – 12/31/2016

Selecting index hospitalization

Definition: Index hospitalization was the hospital admission where the intervention occurred for the HomeMeds patients and the pseudo-intervention date for the control patients.

- For HomeMeds, the intervention date was provided and then a hospitalization was tied from CareConnect data. If a patient had more than one intervention date, the earliest intervention date was selected.
- For control patients, all hospitalizations in the study window were included. Propensity score matching was then used so that the matched-control group was at the patient-level instead of the encounter level.

- Elective index hospitalizations were excluded from both groups. These included the following hospital admission types (variable name: HOSP_ADMSN_TYPE):
    - Elective
    - Obstetrics
    - Newborn
    - Voluntary Elective NPH

- For control patients, hospitalizations were excluded if the admitting service (variable name: ADM_PAT_SERVICE) were the following list:
    - Audiology
    - Care Coordination
    - Dentistry
    - Pediatrics
    - Psychiatry – Adult
    - Psychiatry – Child/Adolescent
    - Quality Assurance
    - Radiation Oncology
    - Radiology – Diagnostic
    - X Service

- For control patients, hospitalizations were excluded if the discharge disposition included the following:
    - Acute Care Hosp
    - Admitted as an inpatient
    - AWOL from UCLA RNPH
    - Children's Hospital or Designated Cancer Center
    - Critical Access Hospital
    - Designated Disaster
    - Discharge to OR
    - ED Dismiss
    - Eloped from ED
    - Expired

- Federal Healthcare facility
- Home Health Service with planned Acute IP readmission
- Home or self care with planned acute ip readmission
- Hospice
- Inpatient Rehab
- Left ED without being seen (LWBS)
- Long Term Acute Facility
- Long Term Care Hospital (LTHC)
- Long Term Care Hospital (LTCH) with planned Acute IP readmission
- Prison/Jail/Law Enforcement
- Prison/Jail/Law Enforcement with planned Acute IP readmission
- Psychiatric Hospital
- SNF Skilled Nursing Bed with planned Acute IP readmission
- SNF/ICF Custodial Care Bed
- SNF/ICF Custodial Care Bed with planned Acute IP readmission
- Still a Patient - Leave of Absence
- SNF Skilled Nursing Bed
- Left ED without being seen (LWBS)
- SNF or Intermediate Care Facility
- Long Term Care Hospital (LTCH)
- Residential Care Facility with planned Acute IP readmission
- Skilled Nursing Facility - Medi-Cal Certified (not Medicare)

Insurance

The intervention targeted Medicare recipients. Raw insurance data is formatted as windows with current medication window open-ended. An insurance was selected if it was active 30 days before or 30 days after index hospitalization. Medicare and Medicaid were derived from the financial class variable in the insurance table (variable name: FIN_CLASS_NAME). Medicare categories were “Medicare” or “MEDICARE ASSIGNED”. Medi-Cal categories were “MEDI-CAL ASSIGNED” or “Medi_Cal”.

Comorbidities

Comorbidities were formatted from the ICD-9 codes in the Care Connect problem list. Patients were deemed to have the condition if the condition was on the problem list one year prior to 30 days after index hospitalization. Conditions and their ICD9 codes are listed below:

- Hypertension: 401, 402, 403, 404, 405, 437.2
- Coronary Artery Disease: 410, 411, 412, 413, 414.2, 414.8, 414.9, 414.00, 414.01, 414.03, 414.06, v45.81, v45.82
- Mental health Dx: 311, 296.2, 296.3, 298.0, 300.0, 300.2, 300.3, 300.4, 300.5, 300.9
- Dementia: 290, 291, 294.1, 294.2, 292.82
- COPD: 490, 491, 492, 493, 494, 496
- CHF: 428, 398.91
- AFib: 427.0, 785.0, 785.1
- AKI: v56, 585.3, 585.4, 585.5, 585.6, 585.9, 792.5, v42.0, v45.1
- Stroke: 343, 430, 431, 432, 433, 434, 435, 436, 438, 342.0, 342.1, 342.8, 342.9, 344, 781.4, 437
- PVD: 444, 445, 557, 440.0, 440.1, 440.4, 440.8, 440.9, 443.9, 440.20, 440.21, 440.22, 440.23, 440.29
- Diabetes: 250, v45.85, v54.91, v65.46, 293.81, 293.82

- Depression: 311, 296.2, 296.3, 298.0
- Mild Cognitive Impairment (MCI): 331

Medications/Med List

Definition: List of provided medications formatted from the med list including number of medications. Medications formatted from list of medication names provided by pharmacists. Medications were included if they were on the medication list 6 months before hospitalization and 30 days after hospitalization. Attempted to filter out vitamins, injectables and topicals using the following keywords:

- Crea
- Cream
- Topi
- Topical
- Foam
- Iv
- Omega
- Multi
- Op oint
- Multivitamin
- Vitamin
- Water
- Calcium
- Mineral oil
- Saline nasal
- Calcium carbonate
- Antacid
- Compound
- Miscellaneous
- Not found
- Unknown
- Gel
- Lotion
- Powder
- Solution
- Suspension
- Drop
- Instill
- Spray
- Meter
- Strip
- Lancet
- Syringe
- Needle
- Compression

- Cholecalciferol
- Cyanocobalamin
- Methylcobalamin
- Magnesium
- Zinc
- Turmeric
- Coenzyme
- Fish
- Citracal
- Probiotic
- Lactobacillus
- Acidophilus
- Ascorbic
- Glucosamine
- Nutritional supplements
- Flaxseed

ED Visits

Outcome variable for ED visit after index hospitalization and risk factor for pre-intervention number of visits. ED visit 30 days post intervention was formatted from the 30 days post-discharge from index hospitalization.

Number of ED visits in the year prior to the index hospitalization was formatted as the count of unique ED visits in the 365 prior to the admission date of the index hospitalization.

Hospitalizations

Outcome variable for hospitalizations after index hospitalization and risk factor for pre-intervention. Pre-hospitalizations were also used for inclusion criteria to the program. All elective procedures were removed from outcomes and pre-intervention hospitalizations. For outcomes variables post-index visits, the window for event starts from index visit discharge. For pre-intervention variables, the window starts from index admit date.

The following variables were derived for analysis:

- LOS of index visit
- Risk factor count: count of variables used to screen people for intervention which includes one points for each for the following for a max score of 6:
- Hospitalization 30 days prior to index or >=2 hospitalizations in the year prior to index
    - LOS of index > 10 days
    - Number of medications >= 8
    - Depression
    - MCI
    - 2 or more chronic conditions which include HT, CAD, CHF, Afib, AKI, stroke, PVD, diabetes, schizophrenia
- Age: this is age at admission of index hospitalization

- Partnership status: were flagged as having partner if variable was married, significant other, life partner, registered domestic partner.
- Race
- Hispanic Ethnicity
- Primary language

Overall control encounters table

- Table is unmatched control encounters and HomeMeds intervention patients.

Variable	Control encounters (n = 20537)	Homemeds (n = 494)	p-value
Female	10534 (51.3%)	307 (62.1%)	<0.001
Race - White	14603 (71.1%)	326 (66%)	0.014
Race - Black	1958 (9.5%)	75 (15.2%)	<0.001
Race - Asian	1515 (7.4%)	37 (7.5%)	0.931
Race - Other/Unknown	2461 (12%)	56 (11.3%)	0.726
Ethnicity - Hispanic	2326 (11.3%)	69 (14%)	0.073
Age	76.5 (70.1-84.7)	83 (76-90)	<0.001
Age - categorical			<0.001
65-74	9149 (44.5%)	112 (22.7%)	
74-84	6400 (31.2%)	155 (31.4%)	
>=85	4988 (24.3%)	227 (46%)	
Primary Language - English	17306 (84.3%)	425 (86%)	0.316
Partnership Status - Married/Partner	9821 (47.8%)	217 (43.9%)	0.092
Hypertension	9819 (47.8%)	284 (57.5%)	<0.001
CAD	4849 (23.6%)	116 (23.5%)	1
Mental Health Dx	2918 (14.2%)	79 (16%)	0.268
Dementia	1312 (6.4%)	51 (10.3%)	0.001
CHF	3421 (16.7%)	98 (19.8%)	0.067
Afib	6011 (29.3%)	159 (32.2%)	0.162
AKI	3482 (17%)	99 (20%)	0.079
Stroke	2561 (12.5%)	69 (14%)	0.335
PVD	1156 (5.6%)	30 (6.1%)	0.622
DM	4140 (20.2%)	104 (21.1%)	0.61
Schizophrenia	375 (1.8%)	8 (1.6%)	0.865
MCI	917 (4.5%)	33 (6.7%)	0.027

Control encounters table continued:

Variable	Control encounters (n = 20537)	Homemeds (n = 494)	p-value
Insulin	2647 (12.9%)	79 (16%)	0.049
Warfarin	1273 (6.2%)	49 (9.9%)	0.002
glucagon_like	18 (0.1%)	0 (0%)	1
biguanide	606 (3%)	19 (3.8%)	0.228
suflonylurea	315 (1.5%)	6 (1.2%)	0.711
meglitinide	97 (0.5%)	3 (0.6%)	0.51
thiazolidinedione	9 (0%)	0 (0%)	1
DPP_4	89 (0.4%)	1 (0.2%)	0.727
alpha_glucosidase	4 (0%)	0 (0%)	1
SGLT_2	20 (0.1%)	0 (0%)	1
anticoagulants	681 (3.3%)	32 (6.5%)	0.001
antiplatelets	1663 (8.1%)	62 (12.6%)	0.001
Number of medications	10 (1-18)	15.5 (10-21)	<0.001
Hospital Visits 1yr prior			<0.001
0	6528 (31.8%)	224 (45.3%)	
1-5	11859 (57.7%)	253 (51.2%)	
>5	2150 (10.5%)	17 (3.4%)	
Any hospital visit 30d prior	6626 (32.3%)	104 (21.1%)	<0.001
Hospitalization w/in 30d	5897 (28.7%)	55 (11.1%)	<0.001
Hospitalization w/in 60d	7730 (37.6%)	113 (22.9%)	<0.001
Hospitalization w/in 90d	8844 (43.1%)	155 (31.4%)	<0.001
ED Visits 1yr prior			<0.001
0	7234 (35.2%)	231 (46.8%)	
1-5	11592 (56.4%)	250 (50.6%)	
>5	1711 (8.3%)	13 (2.6%)	
Any ED visit w/in 30 days	5067 (24.7%)	54 (10.9%)	<0.001
LOS of index hospitalization, mean (SD)	2.9 (5.7)	4.2 (4.4)	NC
Index discharge on a weekend	4999 (24.3%)	75 (15.2%)	<0.001
Count of risk factors			<0.001
1	9136 (44.5%)	149 (30.2%)	
2	6797 (33.1%)	203 (41.1%)	
3	3623 (17.6%)	99 (20%)	
4	865 (4.2%)	40 (8.1%)	
5	109 (0.5%)	3 (0.6%)	
6	7 (0%)	0 (0%)	

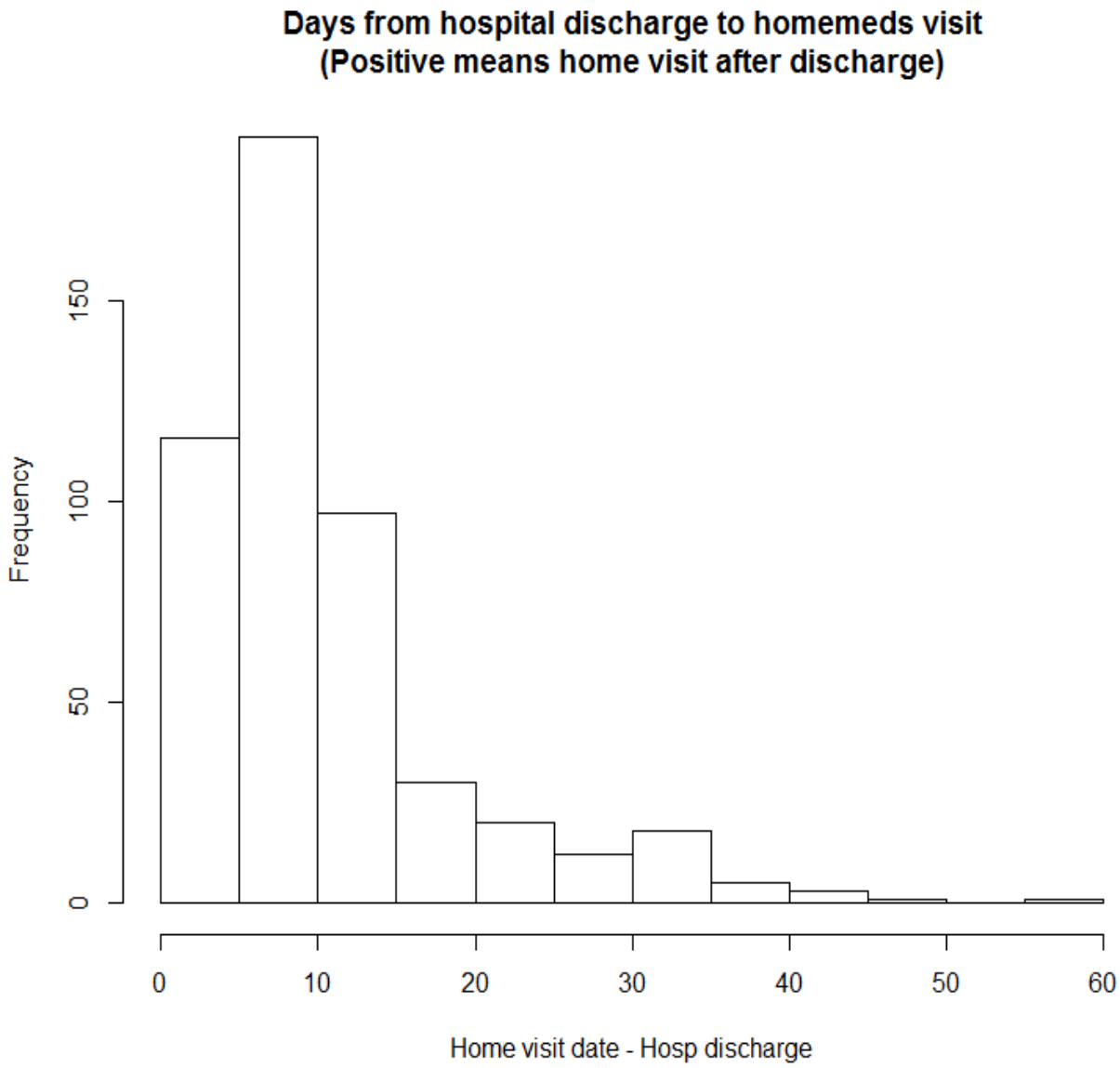
Overall population summary - admit characteristics

Variable	Control encounters (n = 20537)	HomeMeds (n = 494)	p-value
Admit type			0.877
Emergency	18009 (90%)	448 (90.7%)	
Urgent	1969 (9.8%)	46 (9.3%)	
Information Not Available	3 (0%)	0 (0%)	
Trauma Center	21 (0.1%)	0 (0%)	
Voluntary Urgent NPH	1 (0%)	0 (0%)	
Admitting service			<0.001
Emergency Medicine	17462 (89.5%)	415 (84.2%)	
Medicine - CCU/COU	142 (0.7%)	1 (0.2%)	
Medicine - Critical Care (ICU)	41 (0.2%)	1 (0.2%)	
Medicine - General Internal	206 (1.1%)	4 (0.8%)	
Medicine - Geriatrics	345 (1.8%)	43 (8.7%)	
Medicine - Hematology/Oncology	8 (0%)	1 (0.2%)	
Medicine - Hospitalist	586 (3%)	21 (4.3%)	
Medicine - Observation Team	15 (0.1%)	1 (0.2%)	
Medicine - Solid Oncology	185 (0.9%)	2 (0.4%)	
Neurology - Stroke	17 (0.1%)	1 (0.2%)	
Neurosurgery - General	28 (0.1%)	1 (0.2%)	
Neurosurgery - Neuro Critical Care	74 (0.4%)	1 (0.2%)	
Surgery - Cardiac	124 (0.6%)	1 (0.2%)	
Anesthesiology - Pain Management	3 (0%)	0 (0%)	
Family Medicine - Private	1 (0%)	0 (0%)	
Family Medicine - Teaching	4 (0%)	0 (0%)	
Head and Neck Surgery	22 (0.1%)	0 (0%)	
Medicine - Cardiology	10 (0.1%)	0 (0%)	
Medicine - Gastroenterology	4 (0%)	0 (0%)	
Medicine - Infectious Disease	1 (0%)	0 (0%)	
Medicine - Nephrology	0 (0%)	0 (0%)	
Medicine - Oncology/ BMT (J)	62 (0.3%)	0 (0%)	
Medicine - Pulmonary Medicine	3 (0%)	0 (0%)	
Neurology - Epilepsy	0 (0%)	0 (0%)	
Neurology - General	6 (0%)	0 (0%)	
OBGYN - Gynecology	3 (0%)	0 (0%)	
OBGYN - Gynecology Oncology	6 (0%)	0 (0%)	
Orthopaedics	26 (0.1%)	0 (0%)	
Surgery - Bariatric	0 (0%)	0 (0%)	
Surgery - General	12 (0.1%)	0 (0%)	
Surgery - GI (U)	12 (0.1%)	0 (0%)	
Surgery - Oncology (C)	26 (0.1%)	0 (0%)	
Surgery - Plastic	3 (0%)	0 (0%)	
Surgery - Trauma (L)	4 (0%)	0 (0%)	
Surgery - Vascular	47 (0.2%)	0 (0%)	
Urology - General	19 (0.1%)	0 (0%)	
Discharge Disposition			<0.001
Acute Care Hosp UCLA SMHOH	0 (0%)	6 (1.2%)	
Home Health Service	4082 (19.9%)	171 (34.6%)	
Home or Self Care	15996 (77.9%)	257 (52%)	
Hospice Care at Home	0 (0%)	1 (0.2%)	
Inpatient Rehab Facility or Unit (not UCLA)	0 (0%)	1 (0.2%)	
Inpatient Rehab Unit UCLA 1West	0 (0%)	3 (0.6%)	
Left Against Medical Advice (AMA)	155 (0.8%)	1 (0.2%)	
Long Term Care Hospital (LTCH)	119 (0.6%)	1 (0.2%)	
Residential Care Facility	90 (0.4%)	2 (0.4%)	
SNF or Intermediate Care Facility	0 (0%)	23 (4.7%)	
SNF Skilled Nursing Bed	0 (0%)	28 (5.7%)	
Home Health Svc Not Init within 3D of Dsch	4 (0%)	0 (0%)	

Home Health Svc not related to IP stay	3 (0%)	0 (0%)
Left ED without being seen (LWBS)	80 (0.4%)	0 (0%)
Long Term Care Hospital (LTCH) with planned Acute IP readmission	3 (0%)	0 (0%)
Skilled Nursing Facility - Medi-Cal Certified (not Medicare)	5 (0%)	0 (0%)

Summary of time to home visit

- Intervention cases only
- Number of patients with home visit within 30 days of hospital discharge: 466 (94%).
- Mean days from hospital discharge to home visit: 11 (SD = 8.6).



Matched elderly population

- Matched ratio of 5-to-1 on gender, race, age, hypertension, CAD, mental health dx, dementia, chf, afib, AKI, stroke, pvd, diabetes, schizophrenia, MCI, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization

Table 1: Baseline Characteristics, Intervention and Matched Control

Variable	Control (n = 2470)	HomeMeds (n = 494)	p-value
Female	1541 (62.4%)	307 (62.1%)	0.919
Race - White	1674 (67.8%)	326 (66%)	0.461
Race - Black	332 (13.4%)	75 (15.2%)	0.316
Race - Asian	173 (7%)	37 (7.5%)	0.701
Race - Other/Unknown	291 (11.8%)	56 (11.3%)	0.818
Ethnicity - Hispanic	319 (12.9%)	69 (14%)	0.512
Age	82.7 (74.9-89.5)	83 (76-90)	0.476
Age - categorical			0.166
65-74	630 (25.5%)	112 (22.7%)	
74-84	814 (33%)	155 (31.4%)	
>=85	1026 (41.5%)	227 (46%)	
Primary Language - English	2045 (82.8%)	425 (86%)	0.085
Partnership Status - Married/Partner	1102 (44.6%)	217 (43.9%)	0.804
Hypertension	1368 (55.4%)	284 (57.5%)	0.399
CAD	519 (21%)	116 (23.5%)	0.23
Mental Health Dx	356 (14.4%)	79 (16%)	0.366
Dementia	219 (8.9%)	51 (10.3%)	0.304
CHF	462 (18.7%)	98 (19.8%)	0.571
Afib	784 (31.7%)	159 (32.2%)	0.874
AKI	410 (16.6%)	99 (20%)	0.067
Stroke	336 (13.6%)	69 (14%)	0.83
PVD	131 (5.3%)	30 (6.1%)	0.514
DM	500 (20.2%)	104 (21.1%)	0.669
Schizophrenia	36 (1.5%)	8 (1.6%)	0.838
MCI	146 (5.9%)	33 (6.7%)	0.534
Insulin	390 (15.8%)	79 (16%)	0.893
Warfarin	232 (9.4%)	49 (9.9%)	0.736
glucagon_like	2 (0.1%)	0 (0%)	1
biguanide	108 (4.4%)	19 (3.8%)	0.715
suflonylurea	54 (2.2%)	6 (1.2%)	0.219
meglitinide	20 (0.8%)	3 (0.6%)	0.785
thiazolidinedione	3 (0.1%)	0 (0%)	1
DPP_4	21 (0.9%)	1 (0.2%)	0.157
alpha_glucosidase	0 (0%)	0 (0%)	1
SGLT_2	4 (0.2%)	0 (0%)	1
anticoagulants	109 (4.4%)	32 (6.5%)	0.063
antiplatelets	266 (10.8%)	62 (12.6%)	0.271
Number of medications	14 (7-22)	15.5 (10-21)	0.008
Hospital Visits 1yr prior			0.047
0	1235 (50%)	224 (45.3%)	
1-5	1185 (48%)	253 (51.2%)	
>5	50 (2%)	17 (3.4%)	
Any hospital visit 30d prior	443 (17.9%)	104 (21.1%)	0.112

Hospitalization w/in 30d	524 (21.2%)	55 (11.1%)	<0.001
Hospitalization w/in 60d	706 (28.6%)	113 (22.9%)	0.01
Hospitalization w/in 90d	830 (33.6%)	155 (31.4%)	0.347
ED Visits 1yr prior			0.039
0	1292 (52.3%)	231 (46.8%)	
1-5	1138 (46.1%)	250 (50.6%)	
>5	40 (1.6%)	13 (2.6%)	
Any ED visit w/in 30 days	464 (18.8%)	54 (10.9%)	<0.001
LOS of index hospitalization, mean (SD)	4.1 (8)	4.2 (4.4)	NC
Index discharge on a weekend	614 (24.9%)	75 (15.2%)	<0.001
Count of risk factors			<0.001
1	1031 (41.7%)	149 (30.2%)	
2	887 (35.9%)	203 (41.1%)	
3	420 (17%)	99 (20%)	
4	117 (4.7%)	40 (8.1%)	
5	13 (0.5%)	3 (0.6%)	
6	2 (0.1%)	0 (0%)	

Propensity Score Model

Call: glm(formula = as.formula(form_hold), family = binomial,
data = homemeds)

Variable	OR (95% CI)	p-value
female	1.38 (1.14 - 1.67)	0.001
race_white	1 (0.74 - 1.36)	0.977
race_black	2.04 (1.4 - 2.96)	<0.001
race_asian	1.09 (0.7 - 1.69)	0.699
hispanic	1.57 (1.19 - 2.08)	0.001
Age	1.06 (1.05 - 1.07)	<0.001
ht	1.25 (1.02 - 1.53)	0.032
cad	0.92 (0.72 - 1.16)	0.473
mh	1.2 (0.93 - 1.56)	0.155
dem	1.12 (0.81 - 1.53)	0.497
chf	0.99 (0.77 - 1.29)	0.961
af_cd	0.91 (0.74 - 1.13)	0.411
esrd	1.07 (0.83 - 1.37)	0.613
str	1.05 (0.8 - 1.37)	0.726
pvd	1.01 (0.68 - 1.5)	0.960
dm	1.03 (0.81 - 1.31)	0.808
schz	1.05 (0.51 - 2.15)	0.898
mci	1.16 (0.79 - 1.69)	0.445
warfarin	1.28 (0.93 - 1.78)	0.134
Num_of_Meds	1.02 (1.01 - 1.02)	<0.001
hosp_visit_pre_yr	0.62 (0.49 - 0.78)	<0.001
hosp_visit_pre_30d	0.92 (0.73 - 1.17)	0.497
ed_visit_pre_yr	1.41 (1.1 - 1.8)	0.006
LOS_index_hosp	1.01 (0.99 - 1.02)	0.327

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 4682.5 on 21030 degrees of freedom
Residual deviance: 4365.6 on 21005 degrees of freedom
AIC: 4417.6

Number of Fisher Scoring iterations: 8

Matched elderly population - 30 day hospitalization outcome, bivarites

- Matched ratio of 5-to-1 on gender, race, age, hypertension, CAD, mental health dx, dementia, chf, afib, AKI, stroke, pvd, diabetes, schizophrenia, MCI, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization

Variable	No 30d readmission (n = 2385)	30d readmission (n = 579)	p-value
Female	1500 (62.9%)	348 (60.1%)	0.214
Race - White	1611 (67.5%)	389 (67.2%)	0.882
Race - Black	331 (13.9%)	76 (13.1%)	0.686
Race - Asian	173 (7.3%)	37 (6.4%)	0.527
Race - Other/Unknown	270 (11.3%)	77 (13.3%)	0.195
Ethnicity - Hispanic	298 (12.5%)	90 (15.5%)	0.054
Age	83 (75-89.4)	82.2 (74.3-89.9)	0.514
Age - categorical			0.546
65-74	587 (24.6%)	155 (26.8%)	
74-84	784 (32.9%)	185 (32%)	
>=85	1014 (42.5%)	239 (41.3%)	
Primary Language - English	1987 (83.3%)	483 (83.4%)	1
Partnership Status - Married/Partner	1065 (44.7%)	254 (43.9%)	0.744
Hypertension	1294 (54.3%)	358 (61.8%)	0.001
CAD	482 (20.2%)	153 (26.4%)	0.001
Mental Health Dx	329 (13.8%)	106 (18.3%)	0.007
Dementia	204 (8.6%)	66 (11.4%)	0.036
CHF	410 (17.2%)	150 (25.9%)	<0.001
Afib	708 (29.7%)	235 (40.6%)	<0.001
AKI	393 (16.5%)	116 (20%)	0.049
Stroke	297 (12.5%)	108 (18.7%)	<0.001
PVD	128 (5.4%)	33 (5.7%)	0.759
DM	464 (19.5%)	140 (24.2%)	0.013
Schizophrenia	31 (1.3%)	13 (2.2%)	0.122
MCI	138 (5.8%)	41 (7.1%)	0.244
Insulin	367 (15.4%)	102 (17.6%)	0.204
Warfarin	220 (9.2%)	61 (10.5%)	0.343
glucagon_like	2 (0.1%)	0 (0%)	1
biguanide	110 (4.6%)	17 (2.9%)	0.085
suflonylurea	52 (2.2%)	8 (1.4%)	0.253
meglitinide	19 (0.8%)	4 (0.7%)	1
thiazolidinedione	3 (0.1%)	0 (0%)	1
DPP_4	20 (0.8%)	2 (0.3%)	0.286
alpha_glucosidase	0 (0%)	0 (0%)	1
SGLT_2	4 (0.2%)	0 (0%)	1
anticoagulants	115 (4.8%)	26 (4.5%)	0.828
antiplatelets	275 (11.5%)	53 (9.2%)	0.105
Number of medications	14 (8-22)	14 (5.5-23)	0.526
Hospital Visits 1yr prior			<0.001
0	1215 (50.9%)	244 (42.1%)	
1-5	1135 (47.6%)	303 (52.3%)	
>5	35 (1.5%)	32 (5.5%)	
Any hospital visit 30d prior	407 (17.1%)	140 (24.2%)	<0.001
ED Visits 1yr prior			<0.001
0	1260 (52.8%)	263 (45.4%)	
1-5	1100 (46.1%)	288 (49.7%)	
>5	25 (1%)	28 (4.8%)	
Any ED visit w/in 30 days	0 (0%)	518 (89.5%)	<0.001
LOS of index hospitalization, mean (SD)	4.1 (7.6)	4.1 (7.2)	NC
Index discharge on a weekend	547 (22.9%)	142 (24.5%)	0.411

Count of risk factors			<0.001
1	1002 (42%)	178 (30.7%)	
2	863 (36.2%)	227 (39.2%)	
3	395 (16.6%)	124 (21.4%)	
4	108 (4.5%)	49 (8.5%)	
5	15 (0.6%)	1 (0.2%)	
6	2 (0.1%)	0 (0%)	
Group			<0.001
Control	1946 (81.6%)	524 (90.5%)	
HomeMeds	439 (18.4%)	55 (9.5%)	

Matched elderly population summary - 60 day hospitalization outcome, bivariates

- Matched ratio of 5-to-1 on gender, race, age, hypertension, CAD, mental health dx, dementia, chf, afib, AKI, stroke, pvd, diabetes, schizophrenia, MCI, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization

Variable	No 60d readmission (n = 2145)	60d readmission (n = 819)	p-value
Female	1356 (63.2%)	492 (60.1%)	0.117
Race - White	1455 (67.8%)	545 (66.5%)	0.511
Race - Black	296 (13.8%)	111 (13.6%)	0.905
Race - Asian	147 (6.9%)	63 (7.7%)	0.424
Race - Other/Unknown	247 (11.5%)	100 (12.2%)	0.609
Ethnicity - Hispanic	273 (12.7%)	115 (14%)	0.361
Age	82.9 (75-89.4)	82.7 (74.8-90)	0.827
Age - categorical			0.739
65-74	530 (24.7%)	212 (25.9%)	
74-84	709 (33.1%)	260 (31.7%)	
>=85	906 (42.2%)	347 (42.4%)	
Primary Language - English	1791 (83.5%)	679 (82.9%)	0.7
Partnership Status - Married/Partner	962 (44.8%)	357 (43.6%)	0.563
Hypertension	1161 (54.1%)	491 (60%)	0.004
CAD	421 (19.6%)	214 (26.1%)	<0.001
Mental Health Dx	285 (13.3%)	150 (18.3%)	0.001
Dementia	171 (8%)	99 (12.1%)	0.001
CHF	345 (16.1%)	215 (26.3%)	<0.001
Afib	623 (29%)	320 (39.1%)	<0.001
AKI	336 (15.7%)	173 (21.1%)	0.001
Stroke	258 (12%)	147 (17.9%)	<0.001
PVD	108 (5%)	53 (6.5%)	0.124
DM	403 (18.8%)	201 (24.5%)	0.001
Schizophrenia	26 (1.2%)	18 (2.2%)	0.06
MCI	117 (5.5%)	62 (7.6%)	0.038
Insulin	320 (14.9%)	149 (18.2%)	0.032
Warfarin	201 (9.4%)	80 (9.8%)	0.727
glucagon_like	2 (0.1%)	0 (0%)	1
biguanide	96 (4.5%)	31 (3.8%)	0.478
suflonylurea	50 (2.3%)	10 (1.2%)	0.058
meglitinide	14 (0.7%)	9 (1.1%)	0.242
thiazolidinedione	3 (0.1%)	0 (0%)	0.566
DPP_4	18 (0.8%)	4 (0.5%)	0.473
alpha_glucosidase	0 (0%)	0 (0%)	1
SGLT_2	3 (0.1%)	1 (0.1%)	1
anticoagulants	97 (4.5%)	44 (5.4%)	0.335
antiplatelets	250 (11.7%)	78 (9.5%)	0.102
Number of medications	14 (8-22)	15 (6-23)	0.31
Hospital Visits 1yr prior			<0.001
0	1136 (53%)	323 (39.4%)	
1-5	980 (45.7%)	458 (55.9%)	
>5	29 (1.4%)	38 (4.6%)	

Any hospital visit 30d prior	357 (16.6%)	190 (23.2%)	<0.001
ED Visits 1yr prior			<0.001
0	1170 (54.5%)	353 (43.1%)	
1-5	954 (44.5%)	434 (53%)	
>5	21 (1%)	32 (3.9%)	
Any ED visit w/in 30 days	0 (0%)	518 (63.2%)	<0.001
LOS of index hospitalization, mean (SD)	4.1 (7.5)	4.2 (7.6)	NC
Index discharge on a weekend	492 (22.9%)	197 (24.1%)	0.527
Count of risk factors			<0.001
1	930 (43.4%)	250 (30.5%)	
2	772 (36%)	318 (38.8%)	
3	344 (16%)	175 (21.4%)	
4	83 (3.9%)	74 (9%)	
5	14 (0.7%)	2 (0.2%)	
6	2 (0.1%)	0 (0%)	
Group			0.01
Control	1764 (82.2%)	706 (86.2%)	
HomeMeds	381 (17.8%)	113 (13.8%)	

Matched elderly population summary - 90 day hospitalization outcome, bivariates

- Matched ratio of 5-to-1 on gender, race, age, hypertension, CAD, mental health dx, dementia, chf, afib, AKI, stroke, pvd, diabetes, schizophrenia, MCI, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization

Variable	No 90d readmission (n = 1979)	90d readmission (n = 985)	p-value
Female	1261 (63.7%)	587 (59.6%)	0.03
Race - White	1352 (68.3%)	648 (65.8%)	0.17
Race - Black	265 (13.4%)	142 (14.4%)	0.462
Race - Asian	137 (6.9%)	73 (7.4%)	0.649
Race - Other/Unknown	225 (11.4%)	122 (12.4%)	0.431
Ethnicity - Hispanic	242 (12.2%)	146 (14.8%)	0.05
Age	82.9 (75-89.3)	82.7 (74.8-90)	0.9
Age - categorical			0.69
65-74	488 (24.7%)	254 (25.8%)	
74-84	656 (33.1%)	313 (31.8%)	
>=85	835 (42.2%)	418 (42.4%)	
Primary Language - English	1661 (83.9%)	809 (82.1%)	0.229
Partnership Status - Married/Partner	890 (45%)	429 (43.6%)	0.48
Hypertension	1064 (53.8%)	588 (59.7%)	0.002
CAD	375 (18.9%)	260 (26.4%)	<0.001
Mental Health Dx	257 (13%)	178 (18.1%)	<0.001
Dementia	158 (8%)	112 (11.4%)	0.003
CHF	304 (15.4%)	256 (26%)	<0.001
Afib	569 (28.8%)	374 (38%)	<0.001
AKI	293 (14.8%)	216 (21.9%)	<0.001
Stroke	234 (11.8%)	171 (17.4%)	<0.001
PVD	94 (4.7%)	67 (6.8%)	0.025
DM	360 (18.2%)	244 (24.8%)	<0.001
Schizophrenia	25 (1.3%)	19 (1.9%)	0.196
MCI	109 (5.5%)	70 (7.1%)	0.086
Insulin	289 (14.6%)	180 (18.3%)	0.01
Warfarin	183 (9.2%)	98 (9.9%)	0.549
glucagon_like	2 (0.1%)	0 (0%)	1
biguanide	93 (4.7%)	34 (3.5%)	0.124
suflonylurea	48 (2.4%)	12 (1.2%)	0.027
meglitinide	14 (0.7%)	9 (0.9%)	0.515
thiazolidinedione	3 (0.2%)	0 (0%)	0.555
DPP_4	18 (0.9%)	4 (0.4%)	0.173
alpha_glucosidase	0 (0%)	0 (0%)	1

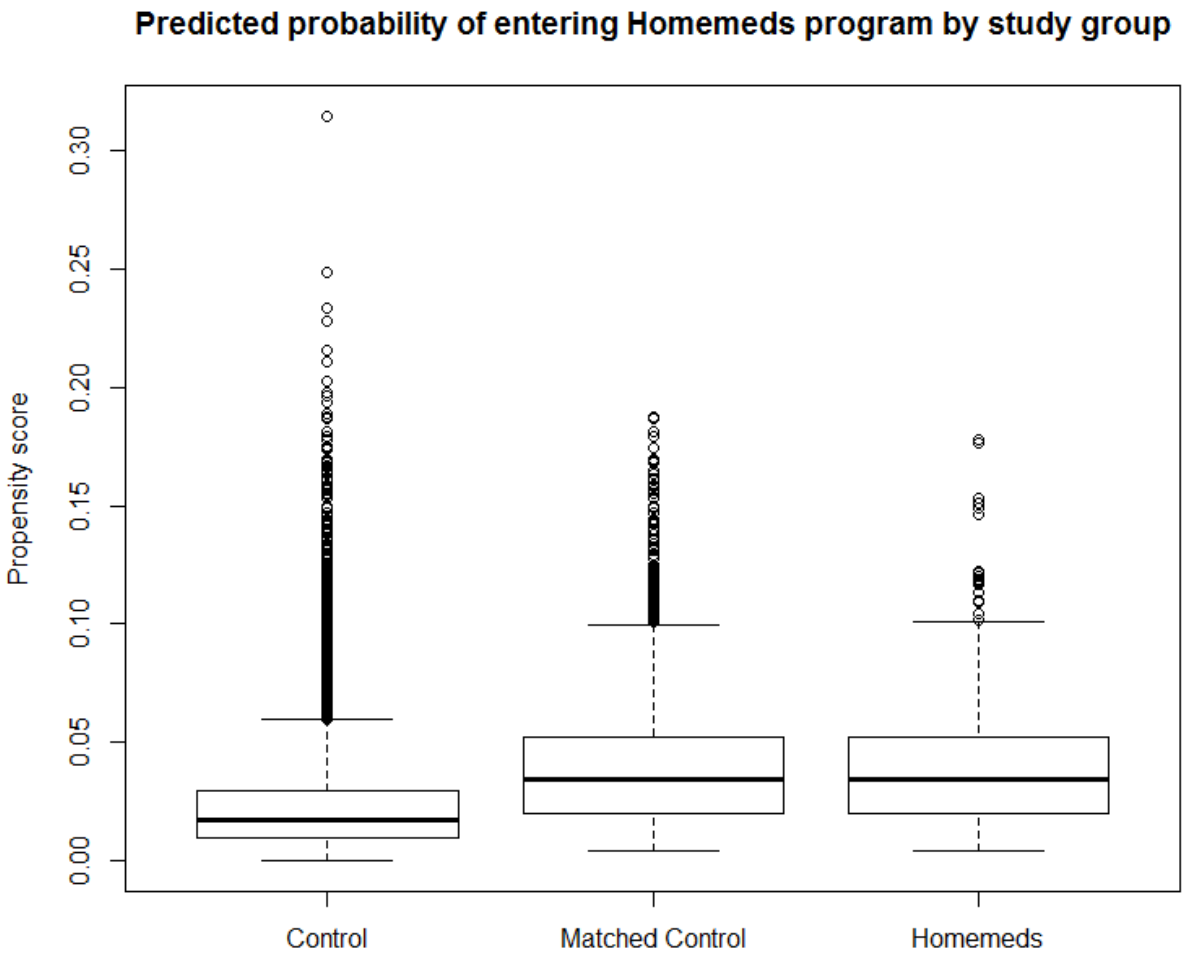
SGLT_2	3 (0.2%)	1 (0.1%)	1
anticoagulants	88 (4.4%)	53 (5.4%)	0.272
antiplatelets	235 (11.9%)	93 (9.4%)	0.047
Number of medications	14 (8-22)	15 (6-23)	0.674
Hospital Visits 1yr prior			<0.001
0	1085 (54.8%)	374 (38%)	
1-5	873 (44.1%)	565 (57.4%)	
>5	21 (1.1%)	46 (4.7%)	
Any hospital visit 30d prior	322 (16.3%)	225 (22.8%)	<0.001
ED Visits 1yr prior			<0.001
0	1114 (56.3%)	409 (41.5%)	
1-5	850 (43%)	538 (54.6%)	
>5	15 (0.8%)	38 (3.9%)	
Any ED visit w/in 30 days	0 (0%)	518 (52.6%)	<0.001
LOS of index hospitalization, mean (SD)	4 (7.4)	4.3 (7.7)	NC
Index discharge on a weekend	453 (22.9%)	236 (24%)	0.518
Count of risk factors			<0.001
1	874 (44.2%)	306 (31.1%)	
2	714 (36.1%)	376 (38.2%)	
3	306 (15.5%)	213 (21.6%)	
4	71 (3.6%)	86 (8.7%)	
5	12 (0.6%)	4 (0.4%)	
6	2 (0.1%)	0 (0%)	
Group			0.347
Control	1640 (82.9%)	830 (84.3%)	
HomeMeds	339 (17.1%)	155 (15.7%)	

Matched elderly population summary - 30 day ED visit outcome, bivariates

- Matched ratio of 5-to-1 on gender, race, age, hypertension, CAD, mental health dx, dementia, chf, afib, AKI, stroke, pvd, diabetes, schizophrenia, MCI, warfarin, number of medications, number of hospital visits in year prior to index visit, whether or not hospital visit 30 days prior to index hospitalization, days from study period start to index hospitalization admission, length of stay of index hospitalization, and number of emergency room visits one year prior to index hospitalization

Variable	No 30d ED visit (n = 2446)	30d ED visit (n = 518)	p-value
Female	1531 (62.6%)	317 (61.2%)	0.55
Race - White	1653 (67.6%)	347 (67%)	0.796
Race - Black	339 (13.9%)	68 (13.1%)	0.725
Race - Asian	176 (7.2%)	34 (6.6%)	0.706
Race - Other/Unknown	278 (11.4%)	69 (13.3%)	0.228
Ethnicity - Hispanic	306 (12.5%)	82 (15.8%)	0.045
Age	82.9 (75-89.4)	82.3 (74.5-90)	0.834
Age - categorical			0.661
65-74	604 (24.7%)	138 (26.6%)	
74-84	804 (32.9%)	165 (31.9%)	
>=85	1038 (42.4%)	215 (41.5%)	
Primary Language - English	2042 (83.5%)	428 (82.6%)	0.65
Partnership Status - Married/Partner	1101 (45%)	218 (42.1%)	0.243
Hypertension	1329 (54.3%)	323 (62.4%)	0.001
CAD	497 (20.3%)	138 (26.6%)	0.002
Mental Health Dx	342 (14%)	93 (18%)	0.024
Dementia	207 (8.5%)	63 (12.2%)	0.011
CHF	423 (17.3%)	137 (26.4%)	<0.001
Afib	734 (30%)	209 (40.3%)	<0.001
AKI	407 (16.6%)	102 (19.7%)	0.096
Stroke	307 (12.6%)	98 (18.9%)	<0.001
PVD	132 (5.4%)	29 (5.6%)	0.831
DM	478 (19.5%)	126 (24.3%)	0.016
Schizophrenia	33 (1.3%)	11 (2.1%)	0.227
MCI	147 (6%)	32 (6.2%)	0.84
Insulin	381 (15.6%)	88 (17%)	0.427

Warfarin	226 (9.2%)	55 (10.6%)	0.323
glucagon_like	2 (0.1%)	0 (0%)	1
biguanide	110 (4.5%)	17 (3.3%)	0.234
suflonylurea	52 (2.1%)	8 (1.5%)	0.493
meglitinide	19 (0.8%)	4 (0.8%)	1
thiazolidinedione	3 (0.1%)	0 (0%)	1
DPP_4	20 (0.8%)	2 (0.4%)	0.406
alpha_glucosidase	0 (0%)	0 (0%)	1
SGLT_2	4 (0.2%)	0 (0%)	1
anticoagulants	119 (4.9%)	22 (4.2%)	0.649
antiplatelets	279 (11.4%)	49 (9.5%)	0.218
Number of medications	14 (8-22)	14 (5-22)	0.783
Hospital Visits 1yr prior			<0.001
0	1249 (51.1%)	210 (40.5%)	
1-5	1161 (47.5%)	277 (53.5%)	
>5	36 (1.5%)	31 (6%)	
Any hospital visit 30d prior	415 (17%)	132 (25.5%)	<0.001
ED Visits 1yr prior			<0.001
0	1298 (53.1%)	225 (43.4%)	
1-5	1123 (45.9%)	265 (51.2%)	
>5	25 (1%)	28 (5.4%)	
LOS of index hospitalization, mean (SD)	4.2 (7.7)	3.8 (6.4)	NC
Index discharge on a weekend	558 (22.8%)	131 (25.3%)	0.229
Count of risk factors			<0.001
1	1019 (41.7%)	161 (31.1%)	
2	889 (36.3%)	201 (38.8%)	
3	406 (16.6%)	113 (21.8%)	
4	115 (4.7%)	42 (8.1%)	
5	15 (0.6%)	1 (0.2%)	
6	2 (0.1%)	0 (0%)	
Group			<0.001
Control	2006 (82%)	464 (89.6%)	
HomeMeds	440 (18%)	54 (10.4%)	


Predicted probability of entering Homemeds program by study group
Propensity score
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Control
Matched Control
Homemeds

Multivariate Regression Models

30-day readmissions:

Variables (p-value < .2). Race-Other/Unknown, Ethnicity-Hispanic, Hypertension, CAD, Mental Health Dx, Dementia, CHF, Afib, AKI, Stroke, PVD, DM, Schizophrenia, Hosptial Vistis 1 year prior, ED visits 1 year prior, Count of risk factors

logistic hosp_visit_30d i.group0_1 race_other_unknown hispanic ht cad mh dem chf af_cd esrd str pvd dm schz hosp_visit_pre_yr ed_visit_
> pre_yr risk_factor_count

```
Logistic regression                               Number of obs   =       2964
                                                  LR chi2(17)     =     122.84
                                                  Prob > chi2     =     0.0000
Log likelihood = -1402.4402                       Pseudo R2       =     0.0420

------------------------------------------------------------------------------
    hosp_visit_30d | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------+----------------------------------------------------------------
        1.group0_1 |   .4217831   .0654575    -5.56   0.000     .3111639    .5717276
race_other_unknown |   1.138722   .1730909     0.85   0.393     .8453392    1.533925
          hispanic |   1.299596    .186548     1.83   0.068     .9808989    1.721839
                ht |   1.050676   .1141183     0.46   0.649     .8492124    1.299934
               cad |   1.106532    .135214     0.83   0.407     .8708639    1.405975
                mh |   1.148347   .1619029     0.98   0.327     .8710921    1.513847
               dem |    1.18759   .1865291     1.09   0.274     .8729155    1.615699
               chf |    1.32143   .1701057     2.17   0.030     1.026763    1.700662
             af_cd |   1.310373   .1476678     2.40   0.016     1.050684    1.634249
              esrd |    .989341    .129718    -0.08   0.935     .7651389    1.279239
               str |   1.436279   .1876226     2.77   0.006     1.111848    1.855377
               pvd |   .7406015   .1586659    -1.40   0.161      .486658    1.127056
                dm |   1.086727   .1326139     0.68   0.496     .8555548    1.380362
              schz |   1.676013   .5772664     1.50   0.134     .8532958    3.291966
 hosp_visit_pre_yr |   1.078623   .1367927     0.60   0.551     .8412382    1.382994
   ed_visit_pre_yr |   1.080898   .1418115     0.59   0.553     .8358129     1.39785
 risk_factor_count |   1.015142   .0713386     0.21   0.831     .8845227     1.16505
             _cons |   .1545226   .0184333   -15.65   0.000     .1223068    .1952242
------------------------------------------------------------------------------
```

. margins group0_1, atmeans

```
Adjusted predictions                Number of obs   =       2964
Model VCE    : OIM

Expression   : Pr(hosp_visit_30d), predict()
at           : 0.group0_1        =    .8333333 (mean)
               1.group0_1        =    .1666667 (mean)
               race_other~n      =    .1170715 (mean)
               hispanic          =    .1309042 (mean)
               ht                =    .5573549 (mean)
               cad               =    .2142375 (mean)
               mh                =    .1467611 (mean)
               dem               =    .0910931 (mean)
               chf               =    .1889339 (mean)
               af_cd             =    .3181511 (mean)
               esrd              =    .1717274 (mean)
               str               =    .1366397 (mean)
               pvd               =    .0543185 (mean)
               dm                =    .2037787 (mean)
               schz              =    .0148448 (mean)
```

hosp_visit~r = 1.074224 (mean)
ed_visit_p~r = 1.006748 (mean)
risk_facto~t = 1.901822 (mean)

	Delta-method				
	Margin	Std. Err.	z	P>|z|	[95% Conf.	Interval]
group0_1						
0	.2058856	.0083114	24.77	0.000	.1895955	.2221757
1	.098574	.013129	7.51	0.000	.0728415	.1243064

**These are the predicted probabilities for intervention and control patients while holding all other variables constant.

. margins group0_1

Predictive margins Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_30d), predict()

	Delta-method				
	Margin	Std. Err.	z	P>|z|	[95% Conf.	Interval]
group0_1						
0	.2139497	.0081239	26.34	0.000	.1980272	.2298722
1	.1055367	.0134356	7.86	0.000	.0792034	.1318699

. margins, dydx(i.group0_1)

Average marginal effects Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_30d), predict()
dy/dx w.r.t. : 1.group0_1

	Delta-method				
	dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.group0_1	-.1084131	.0157319	-6.89	0.000	-.1392471	-.077579

Note: dy/dx for factor levels is the discrete change from the base level.

*A patient who received the intervention is 10.8 percentage points less likely to be readmitted within 30 days compared with a patient who did not receive the intervention, all else equal in the model.

. lroc

Logistic model for hosp_visit_30d

number of observations = 2964
Area under ROC curve = 0.6354

60-day readmissions:

Variables: female, hyptertension, CAD, Mental Health Dx, Dementia, CHF, Afib, AKI, Stroke, PVD, DM, Schizophrenia, MCI, Hospital visits 1 year prior, Any hospital visits 30 days prior, ED visits 1 year prior, count of risk factors.

. logistic hosp_visit_60d i.group0_1 female ht cad mh dem chf af_cd esrd str pvd dm schz mci hosp_visit_pre_yr hosp_visit_pre_30d ed_visi
> t_pre_yr risk_factor_count

Logistic regression Number of obs = 2964
LR chi2(18) = 143.85
Prob > chi2 = 0.0000
Log likelihood = -1675.1755 Pseudo R2 = 0.0412

hosp_visit_60d	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.group0_1	.6751972	.0812506	-3.26	0.001	.5333353	.854793
female	.9013722	.0805682	-1.16	0.245	.7565199	1.07396
ht	.9397358	.0911948	-0.64	0.522	.776967	1.136603
cad	1.064341	.118649	0.56	0.576	.8554442	1.324249
mh	1.193917	.1533711	1.38	0.168	.9281718	1.535748
dem	1.346111	.1920665	2.08	0.037	1.017722	1.78046
chf	1.500233	.1753203	3.47	0.001	1.193124	1.886392
af_cd	1.207126	.1228561	1.85	0.064	.9888279	1.473615
esrd	1.092982	.12813	0.76	0.448	.8686142	1.375306
str	1.430017	.1712375	2.99	0.003	1.130873	1.808291
pvd	.8941942	.166284	-0.60	0.548	.6210732	1.287422
dm	1.155484	.126286	1.32	0.186	.9326829	1.431509
schz	1.670765	.5354186	1.60	0.109	.8915318	3.13108
mci	1.23784	.228269	1.16	0.247	.8623735	1.776781
hosp_visit_pre_yr	1.22013	.1424262	1.70	0.088	.9706104	1.533794
hosp_visit_pre_30d	1.202033	.1362762	1.62	0.105	.9625308	1.50113
ed_visit_pre_yr	.9561787	.115248	-0.37	0.710	.7549948	1.210972
risk_factor_count	1.007029	.0689785	0.10	0.919	.8805157	1.151719
_cons	.25426	.0308276	-11.29	0.000	.2004817	.3224641

. margins group0_1, atmeans

Adjusted predictions Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_60d), predict()
at : 0.group0_1 = .8333333 (mean)
1.group0_1 = .1666667 (mean)
female = .6234818 (mean)
ht = .5573549 (mean)
cad = .2142375 (mean)
mh = .1467611 (mean)
dem = .0910931 (mean)
chf = .1889339 (mean)
af_cd = .3181511 (mean)
esrd = .1717274 (mean)
str = .1366397 (mean)
pvd = .0543185 (mean)
dm = .2037787 (mean)
schz = .0148448 (mean)
mci = .0603914 (mean)
hosp_visit~r = 1.074224 (mean)

hosp_v~e_30d = .1845479 (mean)
ed_visit_p~r = 1.006748 (mean)
risk_facto~t = 1.901822 (mean)

	Delta-method				
	Margin	Std. Err.	z	P>|z|	[95% Conf. Interval]
group0_1					
0	.2805175	.0092685	30.27	0.000	.2623515 .2986834
1	.2083918	.0184264	11.31	0.000	.1722767 .2445069

. margins group0_1

Predictive margins Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_60d), predict()

	Delta-method				
	Margin	Std. Err.	z	P>|z|	[95% Conf. Interval]
group0_1					
0	.2882637	.0089081	32.36	0.000	.2708041 .3057234
1	.2179455	.0180157	12.10	0.000	.1826353 .2532557

. margins, dydx(group0_1)

Average marginal effects Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_60d), predict()
dy/dx w.r.t. : 1.group0_1

	Delta-method				
	dy/dx	Std. Err.	z	P>|z|	[95% Conf. Interval]
1.group0_1	-.0703182	.0201385	-3.49	0.000	-.1097889 -.0308476

Note: dy/dx for factor levels is the discrete change from the base level.

. lroc

Logistic model for hosp_visit_60d

number of observations = 2964
area under ROC curve = 0.6300

90-day readmissions:

Variables: Female, Race-White, Ethnicity-Hispanic, Hypertension, CAD, Mental Health Dx, Dementia, CHF, Afib, AKI, Stroke, PVD, DM, Schizophrenia, MCI, Hospital visit 1 year prior, Hospital visit 30-days prior, ED visit 1 year prior, risk factor count.

logistic hosp_visit_90d i.group0_1 female race_white hispanic ht cad mh dem chf af_cd esrd str pvd dm schz mci hosp_visit_pre_yr hosp_v
> isit_pre_30d ed_visit_pre_yr risk_factor_count

Logistic regression Number of obs = 2964
LR chi2(20) = 189.79
Prob > chi2 = 0.0000
Log likelihood = -1789.6473 Pseudo R2 = 0.0504

hosp_visit_90d	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.group0_1	.8185755	.0909726	-1.80	0.072	.6583551	1.017788
female	.8559332	.073393	-1.81	0.070	.7235233	1.012575
race_white	.916885	.0802043	-0.99	0.321	.7724247	1.088362
hispanic	1.260548	.1492804	1.96	0.051	.9994378	1.589875
ht	.9295204	.0863427	-0.79	0.431	.7748028	1.115133
cad	1.114632	.1200594	1.01	0.314	.9024992	1.376627
mh	1.204632	.1508823	1.49	0.137	.9424105	1.539817
dem	1.255509	.1759466	1.62	0.104	.9539656	1.652369
chf	1.535003	.1743536	3.77	0.000	1.228642	1.917755
af_cd	1.146276	.112777	1.39	0.165	.9452427	1.390065
esrd	1.181707	.13342	1.48	0.139	.947121	1.474397
str	1.402767	.1643286	2.89	0.004	1.114989	1.76482
pvd	.9525292	.1710996	-0.27	0.787	.6698535	1.354493
dm	1.147354	.1221752	1.29	0.197	.9312315	1.413634
schz	1.426917	.4556274	1.11	0.266	.7631372	2.668057
mci	1.182121	.2128296	0.93	0.353	.830637	1.682336
hosp_visit_pre_yr	1.368155	.1633225	2.63	0.009	1.082739	1.728808
hosp_visit_pre_30d	1.114393	.1229071	0.98	0.326	.8977568	1.383305
ed_visit_pre_yr	.9097552	.1112285	-0.77	0.439	.7159042	1.156097
risk_factor_count	.9880307	.0656373	-0.18	0.856	.8674071	1.125428
_cons	.339352	.0450716	-8.14	0.000	.2615752	.440255

. margins group0_1, atmeans

Adjusted predictions Number of obs = 2964
Model VCE : OIM

```
Expression   : Pr(hosp_visit_90d), predict()
at           : 0.group0_1      =    .8333333 (mean)
               1.group0_1      =    .1666667 (mean)
               female          =    .6234818 (mean)
               race_white      =    .6747638 (mean)
               hispanic        =    .1309042 (mean)
               ht              =    .5573549 (mean)
               cad             =    .2142375 (mean)
               mh              =    .1467611 (mean)
               dem             =    .0910931 (mean)
               chf             =    .1889339 (mean)
               af_cd           =    .3181511 (mean)
               esrd            =    .1717274 (mean)
               str             =    .1366397 (mean)
               pvd             =    .0543185 (mean)
               dm              =    .2037787 (mean)
               schz            =    .0148448 (mean)
```

```
                mci             =    .0603914 (mean)
                hosp_visit~r    =    1.074224 (mean)
                hosp_v~e_30d    =    .1845479 (mean)
                ed_visit_p~r    =    1.006748 (mean)
                risk_facto~t    =    1.901822 (mean)

------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    group0_1 |
           0 |   .3325401   .0097896    33.97   0.000     .3133529    .3517273
           1 |   .2896862   .0210144    13.79   0.000     .2484986    .3308738
------------------------------------------------------------------------------
```

. margins group0_1

Predictive margins Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_90d), predict()

```
------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    group0_1 |
           0 |   .3391442   .0092245    36.77   0.000     .3210645    .3572238
           1 |   .2985541      .0199    15.00   0.000     .2595508    .3375573
------------------------------------------------------------------------------
```

. margins, dydx(group0_1)

Average marginal effects Number of obs = 2964
Model VCE : OIM

Expression : Pr(hosp_visit_90d), predict()
dy/dx w.r.t. : 1.group0_1

```
------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  1.group0_1 |  -.0405901   .0219759    -1.85   0.065    -.0836621    .0024819
------------------------------------------------------------------------------
```

Note: dy/dx for factor levels is the discrete change from the base level.

. lroc

Logistic model for hosp_visit_90d

number of observations = 2964
area under ROC curve = 0.6473

30-day ED visits:

Variables: Ethnicity-hispanic, hypertension, CAD, mental health dx, dementia, CHF, afib, AKI, stroke, DM, hospital visits 1 year prior, hospital visit 30 days prior, ED visits 1 year prior, count of risk factors.

. logistic ed_visit_30d i.group0_1 hispanic ht cad mh dem chf af_cd esrd str dm hosp_visit_pre_yr hosp_visit_pre_30d ed_visit_pre_yr risk
> _factor_count

Logistic regression Number of obs = 2964
LR chi2(15) = 119.70
Prob > chi2 = 0.0000
Log likelihood = -1313.5473 Pseudo R2 = 0.0436

ed_visit_30d	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.group0_1	.4832057	.0760175	-4.62	0.000	.3549946	.657722
hispanic	1.389964	.1943119	2.36	0.019	1.056838	1.828093
ht	1.10885	.1266384	0.90	0.366	.8864606	1.38703
cad	1.088912	.138187	0.67	0.502	.849126	1.396412
mh	1.138848	.1682429	0.88	0.379	.8525444	1.521298
dem	1.323139	.2113554	1.75	0.080	.9674671	1.809566
chf	1.405917	.1886567	2.54	0.011	1.080784	1.82886
af_cd	1.276642	.150773	2.07	0.039	1.012841	1.609152
esrd	.9415619	.1293047	-0.44	0.661	.7193717	1.232379
str	1.467138	.198375	2.83	0.005	1.125585	1.912335
dm	1.099618	.1397025	0.75	0.455	.8572347	1.410535
hosp_visit_pre_yr	.9856331	.1323671	-0.11	0.914	.7575336	1.282415
hosp_visit_pre_30d	1.409106	.1804192	2.68	0.007	1.09637	1.811047
ed_visit_pre_yr	1.182852	.164083	1.21	0.226	.9012666	1.552414
risk_factor_count	.9508572	.0706564	-0.68	0.498	.8219854	1.099934
_cons	.1349206	.0167656	-16.12	0.000	.1057561	.1721278

. margins group0_1, atmeans

Adjusted predictions Number of obs = 2964
Model VCE : OIM

Expression : Pr(ed_visit_30d), predict()
at : 0.group0_1 = .8333333 (mean)
1.group0_1 = .1666667 (mean)
hispanic = .1309042 (mean)
ht = .5573549 (mean)
cad = .2142375 (mean)
mh = .1467611 (mean)
dem = .0910931 (mean)
chf = .1889339 (mean)
af_cd = .3181511 (mean)
esrd = .1717274 (mean)
str = .1366397 (mean)
dm = .2037787 (mean)
hosp_visit~r = 1.074224 (mean)
hosp_v~e_30d = .1845479 (mean)
ed_visit_p~r = 1.006748 (mean)
risk_facto~t = 1.901822 (mean)

	Delta-method					
	Margin	Std. Err.	z	P>|z|	[95% Conf.	Interval]

```
    group0_1 |
           0 |   .1801826   .0079255    22.73   0.000     .1646489    .1957163
           1 |    .096005   .0129627     7.41   0.000     .0705986    .1214113
------------------------------------------------------------------------------
```

. margins group0_1

Predictive margins Number of obs = 2964
Model VCE : OIM

Expression : Pr(ed_visit_30d), predict()

```
------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    group0_1 |
           0 |    .189493   .0077553    24.43   0.000     .1742929     .204693
           1 |   .1038564   .0133273     7.79   0.000     .0777353    .1299775
------------------------------------------------------------------------------
```

. margins, dydx(group0_1)

Average marginal effects Number of obs = 2964
Model VCE : OIM

Expression : Pr(ed_visit_30d), predict()
dy/dx w.r.t. : 1.group0_1

```
------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  1.group0_1 |  -.0856366    .015454    -5.54   0.000    -.1159259   -.0553473
------------------------------------------------------------------------------
```

Note: dy/dx for factor levels is the discrete change from the base level.

. lroc

Logistic model for ed_visit_30d

number of observations = 2964
area under ROC curve = 0.6383

Results, Odds Ratios:

Adjusted outcome model

	OR (95% CI)	**Confidence Interval**	**P-value**
30-day hospital readmission	0.42	.31-.57	<0.001
60-day hospital readmission	0.68	.53-.85	0.001
90-day hospital readmission	0.82	.66-1.02	0.072
30-day ED visit	0.48	.35-.66	<.001

Covariates for models were selected by conducting bivariate analyses, and using variables that were significant at p<.2.

Documents used during intervention

HomeMeds: Pharmacist Medication Management Report

**HomeMeds is a community-based post-acute hospitalization home visit performed by health coach who records list of home medications patient is currently taking. This medication reconciliation is based on the home medications documented by health coach, the hospital discharge summary, and the CareConnect medication list.*

HomeMeds Health Coach *** conducted a review of current medications on *** via home visit, and documented any patient self-reported incidents, health-related habits, signs and symptoms, and vital signs. This pharmacist review for potential medication-related problems is based upon review of HomeMeds Health Coach Report.

The HomeMeds Health Coach report will be scanned into Care Connect under Media tab with description "Plan of Care/Home Health".

Current Medications per HomeMeds Report (home visit):

@TAKMED@

Medications listed in CareConnect only (not confirmed if pt is currently taking):

****

Medication listed in HomeMeds Report only (home visit):

****

Assessment/Plan:

1. Patient reported falls in past 3 months: **[ ]** Yes **[ ]** No
Medication(s) that may contribute:
Recommendation: Defer to PCP for evaluation of fall(s). Medication(s) that may contribute to fall risk include ***

2. Patient reported feeling unusually confused in past 3 months: **[ ]** Yes **[ ]** No
Medication(s) that may contribute:
Recommendation: Defer to PCP for evaluation of potential confusion. Medication(s) that may contribute to confusion include ***

3. Patient reports recent dizziness/lightheadheadness upon standing: **[ ]** Yes **[ ]** No
Medication(s) that may contribute:
Recommendation: Defer to PCP for evaluation of potential dizziness. Medication(s) that may contribute to dizziness include ***

Summary of Recommendations:

Please note this is a not a full clinical review of patient's current medication regimen. Please submit referral to MyMeds if comprehensive medication review is desired (this can be done via Meds & Orders tab, with keyword "referral to pharmacists").

1. Patient did not report the following medications to HomeMeds health coach ***. Please clarify at next PCP follow up.

2. Patient reported the following medications to HomeMeds health coach that are not on CareConnect medication list ***. Please clarify at next PCP follow up.

3. Note that patient only showed health coach a list of medications, if there are any concerns about medication management, please submit referral to MyMeds

4.

Medication Discrepancies

Discrepancies	Reported by Patient	Reported by CareConnect or chart review	**Recommended Action**
***; dose/frequency			-Clarify at next PCP visit -referral to MyMeds for in-person medication reconciliation
***; dose/frequency			-Clarify at next PCP visit -referral to MyMeds for in-person medication reconciliation
***; dose/frequency			-Clarify at next PCP visit -referral to MyMeds for in-person medication reconciliation
			-Beers medication, may be inappropriate for use in patients > 65, recommend to assess at next PCP appointment

Please respond to the above medication recommendations via "Quick Note", and route recipient as @MECRED@.

@MECRED@

Partners in Care Foundation

HomeMeds℠ Patient Information Collection Form

MRN: _____

PATIENT

Name: **MRN:** **DOB:** **Gender:** ☐ Male ☐ Female

Phone: **Primary Address:**

HISTORY and ASSESSMENT STATUS

1. **Have you had a fall in the past three months?** ☐ No ☐ Yes

   If yes, ask: **How many times?** _____ *(If more than one fall, record the most serious below.)*

   How did the fall happen? _____

   Did you have any injuries? _____

2. **Do you often feel dizzy or light-headed when you get up from a chair or your bed?** ☐ No ☐ Yes

   If yes, ask: **When do you feel dizzy or lightheaded?** _____

3. **Have you felt unusually confused at any time in the past 3 months** (i.e. couldn't think straight)**?** ☐ No ☐ Yes

4. **Have you been in a hospital, nursing home or ER in the past 3 months**? ☐ No ☐ Yes

5. **How much pain have you experienced recently?** ☐ None ☐ Mild ☐ Moderate ☐ Severe

6. **On average, how many days a week do you drink alcoholic beverages** (beer, wine, liquor)? _____

   If 1+ ask: **On a typical day when you drink, how many drinks do you have?**

CONDITIONS and ALLERGIES

1. **Do you have any chronic conditions?** *If yes, indicate which one(s)*:

☐ Asthma	☐ Anxiety	☐ Cancer of history of cancer	☐ Diabetes – Type 1
☐ Diabetes Type 2	☐ Incontinence	☐ Insomnia	☐ Depression
☐ COPD	☐ High Blood Pressure	☐ Heart Condition	☐ Gastrointestinal Problems
☐ Kidney Problems	☐ Osteoarthritis	☐ Stroke/TIA	☐ Rheumatoid Arthritis

Other conditions/diagnosis: _____

2. **Have you had any surgeries?** ☐ No ☐ Yes **Please describe:**

3. **Do you have any food or medication allergies?** ☐ No ☐ Yes **Please describe:**

HomeMeds Patient Information Collection Form **MRN: _____**

Medication Inventory

PCP Name: _____ Phone #: _____

Oral Medications (including OTC/vitamins/supplements)*

Medication Name	Dose	Instructions for Use (as written on medication bottles)	How is patient taking the medication?	Prescriber	Pharmacy	Last fill date	Refills Remaining	Notes

Medication Name	Dose	Instructions for Use (as written on medication bottles)	How is patient taking the medication?	Prescriber	Pharmacy	Last fill date	Refills Remaining	Notes

Inhaled/Injectables/Topical/Ophthalmic Medications (i.e. inhalers, insulin, patches, creams, eye drops, sprays)*

Medication Name	Dose	Instructions for Use (as written on medication instructions)	How is patient taking the medication?	Prescriber	Pharmacy	Last fill date	Refills Remaining	Notes

**If any information cannot be found, please indicate "not found"*

Coach Name: _____ *Date:* _____ MRN: _____

Problems identified by clinical pharmacist, and illustrative examples of medication-related problems identified

Categories of medication problems	**Number of problems identified, n=100**	**Examples of problems identified**
Discrepancies between Care Connect (EMR) and HomeMeds list	83	Discrepancies included a wide range of prescription medications, OTC meds and supplements. Supplements, allergy meds, inhaled meds, topicals and laxatives were often omitted by the patient/caregiver at the HomeMeds visit.
Patient taking medications or differently than prescribed (e.g., dose, timing)	52	Medications and supplements being taken incorrectly (Anti-hypertensives, diuretics, COPD meds, diabetes meds, B12)

Recent dizziness upon standing or falls reported by patient resulting in recommendation for follow-up with PCP	46	Medications or combinations were possible contributors and PCP follow up was recommended. A partial list included pain meds, hypnotics, CNS depressants, anti-hypertensives, diuretics and anti-spasmodics.
Recommendations were made by clinical pharmacists specific to modifying use of BEERS criteria medications (15)	29	Use of benzodiazepines alone or in combination (alprazolam, lorazepam) Use of hypnotics (zolpidem, exsopiclone) Multiple antiplatelet medications
Potential drug-drug interactions identified or drug-disease interactions identified	27	Medications or combinations with potential to increase risk of bleeding, bradycardia, hyperkalemia or Serotonin Syndrome. Excessive dosage (amlodipine)
Increased confusion reported by patient or giver in last three months resulting in recommendation for PCP evaluation	23	Regimens identified included benzodiazepines, other CNS depressants, pain meds, hypnotics and resulted in a recommendation for PCP follow up.
Polypharmacy/complex regimen simplification recommended	16	Timing of dosing causing interactions or reducing effectiveness was noted. Issues with patients on multiple benzodiazepines, hypnotics and gabapentin were identified.
Lab monitoring recommended	15	TSH (Thyroid-stimulating hormone), BMP (basal metabolic panel), digoxin levels, sodium levels, EKG and monitoring for bleeding risk were suggested, based on medication list
Medications w/o refills, or medications expired	11	Resolution through communication with PCP, patient/caregiver and pharmacies (community and VA) facilitated by clinical pharmacist
Renal/hepatic dose adjustments recommended	10	Changes in dosing were suggested (ranitidine, fexofenadine, and atorvastatin)
Use of NSAIDs and risk for GI bleeding	9	NSAIDs or combinations being prescribed without gastroprotective agent.
Patient continuing to take medications that were discontinued by provider	9	Antibiotics (cephalexin and Bactrim), simvastatin, iron supplementation, vitamin D and folic acid.

Unnecessary therapeutic duplications	9	Dual SNRI(Serotonin-norepinephrine reuptake inhibitors) (duloxetine and milnacipran)
		Multiple antispasmodics
		Treatments for gout (colchicine and allopurinol)

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Chapter V. Transitions in care for patients in skilled nursing facilities: Contribution of clinical pharmacists in reducing utilization through improved medication management

5.1 Abstract

Background/Objective: Changes to medication regimens are common for patients during transitions of care between hospital, post-acute care facilities, and home. These medication changes can result in documentation errors, harmful drug-drug interactions, and patient confusion, which can contribute to adverse drug events and an increased likelihood of subsequent inpatient utilization. The primary objective of this study was to determine whether medication reconciliation and patient education provided by a clinical pharmacist during skilled nursing facility (SNF) care transitions reduced the likelihood of hospital readmissions and emergency department (ED) visits.

Study Design: Retrospective observational study

Setting: UCLA Health and affiliated SNF located in Los Angeles, CA

Population Studied: Medicare or commercially-insured adult patients (age 50 and older) who were hospitalized between March 2015 and April 2016, and were then discharged to a SNF with the expectation of being discharged to home. A total of 300 patients received the intervention, and 1,409 patients were included in the control group. The intervention was conducted at a single SNF. The control group was comprised of similar patients from nearby, non-intervention site SNFs.

Intervention: The clinical pharmacist conducted medication reconciliation following the transfer of a patient between the hospital and SNFs, generated a hard copy medication list for the

patient, and completed an in-person consultation with the patient and/or caregiver at the time of discharge from the SNF.

Measurements: 60-day hospital readmissions and emergency department (ED) visits

Principal Findings: In multivariate GEE logistic regression models that adjusted for patient-level demographic and clinical covariates and a propensity score, receiving the intervention was associated with a significant reduction in 60-day hospital readmissions [AOR 0.73; 95% CI: 0.53-0.99). No significant effect was observed for ED visits.

Conclusions: This clinical pharmacist intervention that aimed to reduce utilization through medication review and patient education during transitions in the post-acute care setting was associated with a significant reduction in 60-day hospital readmissions.

5.2 Introduction

Ineffective transitions of care can result in poor patient outcomes and increased healthcare costs (1). Complications that arise following a care transition have been associated with an increased likelihood of hospital readmissions (2-5). Among Medicare patients who are discharged from the hospital, approximately 20% are readmitted within 30 days, and 34% within 90 days (6). In the post-acute care setting, specifically skilled nursing facilities (SNFs), approximately 23% of patients who are discharged from a SNF to home are readmitted to the hospital within 30 days (7).

Medication-related challenges (e.g., medication list discrepancies, inability among patients to adhere to or manage their drug regimens) and adverse drug events (ADEs) are accentuated following care transitions, and are a frequent contributor to hospital readmissions (8-11). One reason for this is that medication regimens often change for patients during hospitalization and while in a post-acute care facility, which can lead to documentation errors, confusion, and medication misuse among patients (12, 13). Descriptive studies that have documented the inaccuracies that occur during hand-offs between hospitals and SNFs found discrepancies between discharge summaries and medication lists in 75-90% of patients who transitioned from a hospital to a SNF (14, 15). Given the observed association between care transitions, medication complications, and readmissions, directing resources toward practices that improve medication accuracy and adherence and reduce preventable ADEs has been identified as an important component of care transition programs (16, 17).

Care transitions between post-acute care facilities and home is underexplored compared with care transitions between hospital and home (18). The few existing studies that have explored transitions between SNFs and home have been limited methodologically (e.g., pre-post,

single site designs) and in sample size (19-23). The limited research focused on SNFs is likely attributable to several factors, including that SNFs have been slower to adopt electronic medical records (EMR) that allow for data capture and analysis. In addition, if a SNF does have an EMR, lack of interoperability with hospitals makes it challenging to track patients across settings. Because patients who transition from SNFs are often older, taking multiple medications, managing complex chronic conditions, and have undergone an additional hand-off compared with those who transition from hospital to home, investigation of interventions that address the specific needs of this vulnerable population is warranted.

Clinical pharmacists have been shown to improve patient outcomes and lower costs as part of teams in the primary care setting (24-26). With their training in medication reconciliation, medication therapy management, and medication regimen adjustments, clinical pharmacists have the potential to play an effective role during transitions in the post-acute care setting. The objective of this study was to examine the impact of a clinical pharmacist intervention that sought to reduce medication discrepancies and improve patient self-management upon discharge to home with the goal of reducing hospital readmissions and emergency department visits. Our hypothesis was that patients who received the clinical pharmacist intervention would have reduced inpatient utilization compared with patients who do not receive the intervention.

5.3 Methods

Study Setting and Study Design

The intervention took place between March 2015 and April 2016, and was a collaboration between UCLA Health and a UCLA-affiliated SNF. To evaluate the effect of this intervention on the outcomes of interest—hospital readmissions and unplanned ED visits— we conducted an

observational, non-randomized study using a control group comprised of patients from nine UCLA-affiliated SNFs located throughout Los Angeles County.

UCLA Health is a comprehensive healthcare system with two hospitals and 33 primary care clinics. The intervention SNF is a short-term, privately owned, 211-bed post-acute care facility that is staffed in part by UCLA Health geriatricians. All control site SNFs are staffed in part by UCLA Health geriatricians or hospitalists. The study was approved by the institutional review board of the University of California, Los Angeles (UCLA).

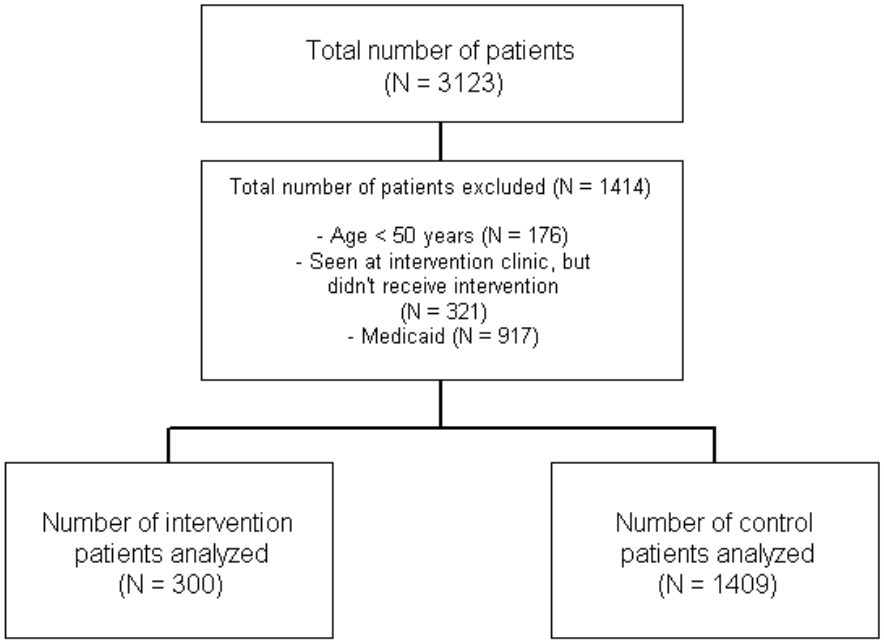
Study Population

Intervention patients included individuals who had an assigned UCLA Health primary care physician (PCP), and were discharged from a UCLA-affiliated hospital to the intervention SNF during the study period with a discharge code indicating they would be discharged to home following a short-term SNF stay (i.e., not discharged to hospice, nursing home, or scheduled for a planned readmission to hospital). Inclusion criteria for control patients were the same as those for intervention patients except that control patients were admitted to one of the UCLA-affiliated control site SNFs.

Control patients were identified with an index hospitalization at a UCLA hospital. If a patient had more than one index hospitalization during the study period, the first hospitalization was used. In addition, as the goal of this intervention was to examine the impact of a clinical pharmacist on improving medication management specifically among older adults taking multiple medications and managing complex chronic conditions, we excluded patients who were under the age of 50. We also restricted our study population to those with Medicare or

commercial insurance due to an imbalance between patients in the intervention and control groups who were eligible for Medicaid.

Figure 5-1: Study Flow Diagram, SNF/MyMEDS



Intervention

This intervention was an extension of a system-wide, UCLA Health clinical pharmacist program that began in 2012 called Managing your Medications for Education and Daily Support (MyMEDS). MyMEDS embeds clinical pharmacists in ambulatory clinics to co-manage patients with primary care physicians. The primary goals of the MyMEDS program are to improve medication adherence; decrease polypharmacy; reduce medication costs; improve safety; and manage uncontrolled diabetes, hypertension, and hyperlipidemia. While the SNF-based intervention was modeled after MyMEDS and used the existing infrastructure of the program, this intervention was tailored to meet the specific needs of the SNF patients.

During the 13-month study period, the clinical pharmacist was physically located at the SNF one day each week. For all intervention patients, the clinical pharmacist reviewed the patient's records upon admission from the hospital to the SNF. The clinical pharmacist identified and corrected medication errors (e.g., unintended orders or omissions that occurred during the transition from the hospital to the SNF), made therapeutic substitutions that simplified a patient's medication regimen such as changing to a once a day formulation of the same medication, and made changes to dose or administration of a drug as needed. The clinical pharmacist also prepared a detailed, hard copy medication list that highlighted changes made to a patient's medication regimen, and directions for provider management and patient self-management.

For just under half (n=137) of all intervention patients (n=300), the clinical pharmacist met with patients and their caregivers, if available, at the time of discharge to review the medication list, engage in a "teach back" to ensure patients understood the regimens, and identify potential barriers to adherence. Determination of which intervention patients received this in-person consultation at the time of discharge from SNF to home was made entirely by the clinical pharmacist's availability. All documentation was completed in the UCLA Health electronic medical record (EMR). The clinical pharmacist also sent a note to the patient's PCP describing all changes made to the medication list, and indicating whether the patient had a PCP follow-up appointment scheduled.

Primary Outcome Measures and Covariates

The primary outcome measures were 60-day hospital readmissions and 60-day emergency department (ED) visits. These data were obtained from UCLA Health administrative data. We selected the 60-day measure instead of the 30-day readmission measure because we were not able to obtain the SNF discharge date for all patients in the study. We determined that

the 60-day time period would serve as a more appropriate measure for assessing the impact of this pharmacist intervention on patients who were discharged home.

Our primary predictor was whether or not a patient received the MyMeds intervention. We included several patient demographic and clinical variables as covariates in the model: age, gender, race/ethnicity, number of hospitalizations in the previous 12 months prior to index hospitalization, hospital length of stay that preceded discharge to the SNF, reason for index hospitalization, and whether the patient had certain comorbidities—diabetes, hypertension, and dementia. The selection of covariates was informed by a conceptual model and existing literature addressing predictors of readmission.

Statistical Analysis

We compared baseline demographic and clinical characteristics of the intervention and control groups using t-tests for continuous variables and Chi-squared tests for categorical variables. To evaluate the impact of the intervention on our outcomes of interest, we estimated a logistic regression model using generalized estimating equation (GEE) to account for potential clustering within SNFs. Due to the observed differences in baseline characteristics between the intervention and control groups, we also generated a propensity score to estimate the likelihood of receiving the intervention and included this as an additional covariate in the regression model. We selected this propensity score approach because it better preserves the sample of the population that was queried, and it allows for predicting receipt of the treatment, followed by multiple logistic regression.

We performed several sensitivity analyses. In addition to the main model—logistic regression with GEE specification and the propensity score—we evaluated the impact of the

intervention on the outcomes of interest using several alternative methods: multivariate model without the GEE specification, and without the propensity score, as well as a propensity score model with nearest neighbor matching. The results for the full model and sensitivity analyses are presented in the Appendix.

To account for missing variables, we used multivariate imputation by chained equations with predictive mean matching for continuous variables and logistic regression for dichotomous variables. The variables with missing data include marital status (n=9), index hospital length of stay (n=86), emergent index hospitalization (n=86) and age (n=86). Finally, we examined the monthly readmission rates for both the intervention and control SNFs to determine whether secular trends (e.g., consistent decline over time in hospital readmissions) might influence our results.

Stata (IC-12; StataCorp LP, College Park, TX, USA) and R (R Core Team, Vienna, Austria) were used to conduct the statistical analyses. URSA (URSA Health, Nashville, TN, USA) was used for data extraction and formatting of patient-level clinical and utilization data.

5.4 Results

Patient Characteristics

A total of 3,123 patients were discharged from a UCLA-affiliated hospital to a UCLA-affiliated SNF between March 2015 and April 2016. Of these, 1,709 patients met the study inclusion criteria, 300 of whom received the clinical pharmacist intervention. Table 1 shows descriptive statistics for intervention and control patients. Compared with patients in the control group, patients who received the intervention were significantly more likely to be older (81.9 vs. 78.7, $p<0.001$) and female (69.0% vs. 56.2%, $p<0.001$). Intervention patients were also more

likely to have had an elective versus non-elective reason for hospitalization prior to discharge to the SNF (26.3% vs. 17.4%, p<0.001), and a shorter length of stay in the hospital compared with control patients (4 days vs. 6 days, p<0.001). The intervention and control patients showed no statistically significant differences in the prevalence of certain comorbidities (e.g., diabetes, hypertension, and dementia), marital status, or in race/ethnicity.

Table 5-1: Baseline Characteristics, MyMEDS and Control Patients

Variable	MyMeds Pts (n = 300)	Control Pts (n = 1409)	P-value
Age, mean (SD)	81.9 (10.6)	78.7 (11)	<0.001
Female	207 (69%)	792 (56%)	<0.001
Race/Ethnicity			0.171
White	221 (73.7%)	964 (68.4%)	
Black	21 (7%)	138 (9.8%)	
Hispanic	12 (4%)	100 (7.1%)	
Asian	21 (7%)	111 (7.9%)	
Other	25 (8.3%)	96 (6.8%)	
Marital status			0.076
Divorced/separated/widow/single	194 (64.7%)	817 (58%)	
Married/partner/ significant other	106 (35.3%)	592 (42%)	
Index hospitalization LOS, median (IQR)	4 (3-7)	6 (4-11)	<0.001
Number of medications, median (IQR)	10 (7-13)	13 (9-17)	<0.001
Index hospitalization admission type			
Elective	79 (26.3%)	245 (17.4%)	<0.001
Non-Elective	221 (73.7%)	1164 (82.6%)	<0.001
Comorbidity – Diabetes	18 (6%)	127 (9%)	0.089
Comorbidity - Hypertension	41 (13.7%)	251 (17.8%)	0.083
Comorbidity – Dementia	14 (4.7%)	82 (5.8%)	0.431
Hospitalizations in previous year	109 (36.3%)	416 (30.3%)	0.080

Patient-level unadjusted and adjusted outcomes

Intervention patients had a significantly lower unadjusted rate of hospital readmissions (14.7% vs. 20.7%, p=0.017) and unplanned ED visits (17.3% versus 25.6%, p=0.002). After adjusting for patient-level covariates and the propensity score, patients who received the clinical

pharmacist intervention were significantly less likely to be readmitted within 60-days (OR 0.73, p=0.041) compared with patients who did not receive the intervention. No significant effect was found for ED visits. For the sensitivity analyses—propensity score matching, inverse probability weighting, and the logistic regression model without the GEE specification and the propensity score—results were similar to those of the main model. Our investigation of the monthly readmission rates in the year prior to the intervention revealed no systematic trends, suggesting that secular trends were not the reason for our observed findings.

Table 5-2: Unadjusted Rates, 60-day Hospital Readmissions and 60-day ED Visits

Outcomes	**MyMEDS (n=300)**	**Control (n=1409)**	**P-value**
60-day readmissions	44 (14.7%)	292 (20.7%)	0.017
60-day ED visits	52 (17.3%)	361 (25.6%)	0.002

Table 5-3: Summary of Multivariate Models*

Model	OR (95% CI)	p-value
60-day Hospitalizations		
GEE with propensity score	0.73 (0.55 - 0.97)	0.031
GLM with propensity score	0.73 (0.51 - 1.06)	0.102
GEE without propensity score	0.71 (0.53 - 0.94)	0.016
GLM without propensity score	0.71 (0.49 - 1.02)	0.067
IPW	0.65 (0.39 - 1.11)	0.114
60-day ED Visits		
GEE with propensity score	0.78 (0.35 - 1.74)	0.537
GLM with propensity score	0.66 (0.46 - 0.93)	0.017
GEE without propensity score	0.77 (0.35 - 1.68)	0.513
GLM without propensity score	0.64 (0.45 - 0.9)	0.011
IPW	0.69 (0.41 - 1.16)	0.165

*10 imputed datasets were used for the modeling.

5.5 Discussion

In this study, we found that the clinical pharmacist intervention was associated with a significant reduction in 60-day hospital readmissions after adjusting for patient-level covariates and a propensity score. We did not find a significant effect for 60-day ED visits. Our study contributes to the post-acute care transition literature in that it is among the few to evaluate the use of a clinical pharmacist at the point of transition between the acute care hospital, SNF, and home setting to address medication list accuracy, medication reconciliation, patient education, and promotion of medication adherence with the goal of reducing subsequent inpatient utilization. Methodologically, our study advances the current literature by utilizing a comparison group and testing the intervention in a large, non-integrated academic health system with a diverse patient population.

While the pathway by which the clinical pharmacist intervention influenced a reduction in hospital readmissions cannot be immediately determined by our data, the significant difference observed in readmission rates is notable. We hypothesize that there are several plausible mechanisms by which the intervention had an effect on reducing adverse drug events and ultimately hospital readmissions. One possible pathway is through the clinical pharmacist's identification and correction of discrepancies in inter-facility orders that occurred when the patient transitioned from the hospital to the SNF. Examples of this include (1) identifying missing orders for certain medications, (2) identifying that a particular drug had been discontinued in the discharge summary, but included in the inter-facility order, or (3) identifying incomplete inter-facility orders. A second possible pathway is that the clinical pharmacist identified changes made to a patient's medication list, and communicated those changes on the hard copy medication list given to the patient at the time of discharge from the SNF to home. A

third possible pathway is through patient education and the clinical pharmacist's use of techniques to identify and address barriers to adherence. The clinical pharmacist had been trained in motivational interviewing strategies and patient "teach back" approaches where the patient was encouraged to verbalize the medication regimen, clarify points of confusion, and engage in discussion around preferences and values as they relate to taking medications.

While our study results compare similarly to others that have focused on care transitions in the SNF setting and medication challenges in particular, the limited number of studies that address this topic make it difficult to draw definitive conclusions. We identified only six studies that have tested interventions that aim to improve patient outcomes in care transitions between SNF and home, and only two have focused on medication management. The majority of the studies we identified were nurse-led interventions, and included features such as follow-up phone or in-person home visits, exercise monitoring, and training patients to self-manage their conditions (19-22).

Of the two studies that involved medication management (16,22), one was a nurse-led intervention that included a two-hour consultation between a nurse and the patient at the time of discharge from the SNF, and also included arrangement of home health services, medication reconciliation, education around medications, and a post-discharge plan (22). This study found that intervention patients had significantly lower inpatient utilization compared with patients from the pre-period. This study was limited, however, in that it was a pre-post design with no control group and was conducted at a single VA facility where the study sample was 95% male. The second medication-focused study was conducted at Kaiser and used a non-randomized design with a control group to assess the impact of a clinical pharmacist intervention that used medication review and home-based medication reconciliation (16). This study found no

difference between the intervention and control groups with regard to emergency visits or hospital readmissions following discharge from SNF to home, but did find that the intervention patients had reduced risk of death (16). The authors note that they had limited power to detect changes in many of their outcomes of interest due to small sample size.

From a policy standpoint, the move towards value-based care and increasing provider accountability through new models of care and reimbursement reform (e.g., accountable care organizations, bundled payments) give health systems and providers incentive to provide comprehensive care that extends beyond a patient's hospital stay. In 2019, for example, the SNF value-based purchasing (VBP) program will go into effect, the primary objective of which is to make SNFs more accountable for patient outcomes. This policy change, coupled with the existing CMS Hospital Readmission Reduction Program that penalizes hospitals for readmissions that exceed the CMS threshold, could incentivize health systems and post-acute care facilities to collaborate with the goal of reducing readmissions for older, vulnerable patients. This pilot demonstrates one potential way by which a health system can partner with a SNF, namely by placing a clinical pharmacist employed by the health system in the SNF, which gives more control to hospitals with regard to patient outcomes.

Limitations

Our study has several limitations. First, because the study was not randomized, it is possible that we did not control for unobservables that could influence our primary outcome (e.g., social support and socioeconomic factors). Second, the health system data used for this analysis do not allow us to know whether a patient was readmitted to a hospital outside of the health system where this intervention took place. Given that all of the intervention and control patients had an assigned PCP within this health system, however, we do not believe this would

significantly change our findings. Third, we were not able to control for variations in SNFs (e.g., variation in care practices that might influence hospital readmissions) in our multivariate model. We attempted to address this limitation by investigating the monthly readmission rates across the control site SNF, from which we determined there were no secular trends in the period immediately preceding the intervention. Finally, with regard to generalizability, this intervention was based upon and made use of an existing, successful clinical pharmacist program. Health systems and SNFs considering implementing this type of intervention may need to consider the investment in training and infrastructure required to increase the likelihood of success for this sort of cross facility intervention.

Conclusion

This study demonstrates the potential benefits that clinical pharmacists can offer for patients who transition to and from skilled nursing facilities. As interventions that focus on care transitions in the post-acute care setting continue to be developed and evaluated, it will be important to study the isolated effect of medication management and patient education that focuses on self-management and adherence as mechanisms for improved outcomes.

5.6 Appendix, Post-acute Care Transitions Evaluation

SNF Formatting

Study window: 3/1/2015 – 4/30/2016

Selecting index hospitalization

Definition: Index hospitalization was the hospital admission where the patient was discharged to a SNF.

- For SNF/MyMEDS (intervention) patients, the intervention date was provided and then a hospitalization was tied from URSA data.

- For control patients, each patients' earliest hospitalization that led to a SNF visit within the study window was chosen. FPG provided a separate file of just patients who were discharged to a SNF and controls were chosen from this population. Control patients were excluded if they were discharged to Berkley East.

Insurance

Definition: Insurance abstracted from CareConnect. The intervention targeted Medicare recipients. Raw insurance data is formatted as windows with current medication window open-ended. An insurance was flagged if it was effective during index hospitalization. Medicare, Medicaid, Commercial, and Other were derived from the financial class variable in the insurance table (variable name: FIN_CLASS_NAME). Medicare categories were "Medicare" or "MEDICARE ASSIGNED". Medical categories were "MEDI-CAL ASSIGNED" or "Medi_Cal". Commercial insurance included "Group Health Plan", "Commercial ", or "UCLA Managed Care". Other insurance included "Other", "International Payor", "Package Billing", "Tricare", "Willow Ambulatory", or "Workers Comp".

Comorbidities/Problem list

Definition: Comorbidities were formatted from the ICD-9 codes in the CareConnect problem list. Patients were said to have the condition if the condition was on the problem list one year prior to day of discharge from index hospitalization. Conditions and their ICD9 codes are list below:

- Hypertension: 401, 402, 403, 404, 405, 437.2
- Coronary Artery Disease: 410, 411, 412, 413, 414.2, 414.8, 414.9, 414.00, 414.01, 414.03, 414.06, v45.81, v45.82
- Mental health Dx: 311, 296.2, 296.3, 298.0, 300.0, 300.2, 300.3, 300.4, 300.5, 300.9
- Dementia: 290, 291, 294.1, 294.2, 292.82
- COPD: 490, 491, 492, 493, 494, 496
- CHF: 428, 398.91
- AFib: 427.0, 785.0, 785.1
- AKI: v56, 585.3, 585.4, 585.5, 585.6, 585.9, 792.5, v42.0, v45.1
- Stroke: 343, 430, 431, 432, 433, 434, 435, 436, 438, 342.0, 342.1, 342.8, 342.9, 344, 781.4, 437

- PVD: 444, 445, 557, 440.0, 440.1, 440.4, 440.8, 440.9, 443.9, 440.20, 440.21, 440.22, 440.23, 440.29
- Diabetes: 250, v45.85, v54.91, v65.46, 293.81, 293.82
- Depression: 311, 296.2, 296.3, 298.0

Medications/Med List

Definition: List of provided medications formatted from the CareConnect med list including number of medications. Medications formatted from list of medication names provided by pharmacists. Medications were included if they were on the med list 6 months before hospitalization and 30 days past hospitalization. Attempted to filter out vitamins, injectables and topicals using the following keywords:

- Crea
- Cream
- Topi
- Topical
- Foam
- Iv
- Omega
- Multi
- Op oint
- Multivitamin
- Vitamin
- Water
- Calcium
- Mineral oil
- Saline nasal
- Calcium carbonate
- Antacid
- Compound
- Miscellaneous
- Not found
- Unknown
- Gel
- Lotion
- Powder
- Solution
- Suspension
- Drop
- Instill
- Spray
- Meter
- Strip
- Lancet
- Syringe

- Needle
- Compression
- Cholecalciferol
- Cyanocobalamin
- Methylcobalamin
- Magnesium
- Zinc
- Turmeric
- Coenzyme
- Fish
- Citracal
- Probiotic
- Lactobacillus
- Acidophilus
- Ascorbic
- Glucosamine
- Nutritional supplements
- Flaxseed

ED Visits

Definition: Outcome variable for ED visit after index hospitalization and pre-intervention. Data from Family Practice Group. ED visit post hospitalization was formatted from the discharge date.

Hospitalizations

Definition: Outcome variable for hospitalizations after index hospitalization and risk factor for pre-intervention. Data from Family Practice Group.

Derived variables

The following variables were derived for analysis:

- LOS of index visits
- Age: Age at admission of index hospitalization
- Marital status was abstracted from CareConnect.
    - Partnership status: Flagged as having partner if variable was married, significant other, life partner, registered domestic partner, or life partner.
- Race
- Hispanic Ethnicity
- Primary language

Logistic Regression with gee and propensity score

- P-value based on Wald test statistic.

Hospitalization 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.72 (0.51 - 1.02)	0.066
Propensity score	0.17 (0.03 - 1.1)	0.063
Age	1.01 (1 - 1.02)	0.228
Female	0.9 (0.68 - 1.17)	0.429
Race - white	0.91 (0.81 - 1.01)	0.086
Admit type - non-elective	1.36 (0.93 - 1.98)	0.11
Hospital LOS	1.01 (1 - 1.02)	0.147
Total number of medications	1 (0.96 - 1.04)	0.928
DM	0.87 (0.55 - 1.4)	0.574
Hypertension	0.83 (0.69 - 1)	0.054
Dementia	0.59 (0.35 - 1)	0.05
Marital status - Married/partner	0.95 (0.81 - 1.1)	0.477
Number of hospitalizations previous 12 months	1.46 (1.28 - 1.67)	<0.001

ED 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.7 (0.3 - 1.67)	0.428
Propensity score	0.35 (0.07 - 1.82)	0.213
Age	1.01 (1 - 1.02)	0.013
Female	0.99 (0.82 - 1.2)	0.946
Race - white	1.01 (0.9 - 1.14)	0.861
Admit type - non-elective	1.86 (1.36 - 2.56)	<0.001
Hospital LOS	1.02 (0.99 - 1.04)	0.177
Total number of medications	1 (0.98 - 1.03)	0.716
DM	0.99 (0.67 - 1.46)	0.965
Hypertension	0.94 (0.83 - 1.06)	0.311
Dementia	0.68 (0.44 - 1.05)	0.081
Marital status - Married/partner	0.95 (0.72 - 1.27)	0.736
Number of hospitalizations previous 12 months	1.4 (1.26 - 1.56)	<0.001

Logistic Regression with gee without propensity score

- P-value based on Wald test statistic.

Hospitalization 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.7 (0.5 - 0.98)	0.037
Age	1 (0.99 - 1.01)	0.873
Female	0.97 (0.71 - 1.33)	0.871
Race - white	0.88 (0.78 - 0.99)	0.032
Admit type - non-elective	1.58 (1.17 - 2.14)	0.003
Hospital LOS	1.02 (1 - 1.03)	0.028
Total number of medications	1.02 (1 - 1.05)	0.108
DM	0.86 (0.54 - 1.38)	0.533
Hypertension	0.87 (0.72 - 1.06)	0.164
Dementia	0.64 (0.39 - 1.04)	0.074
Marital status - Married/partner	0.97 (0.82 - 1.14)	0.702
Number of hospitalizations previous 12 months	1.37 (1.25 - 1.5)	<0.001

ED 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.64 (0.45 - 0.91)	0.012
Age	1.01 (1 - 1.02)	0.001
Female	1.04 (0.8 - 1.35)	0.756
Race - white	1.02 (0.88 - 1.19)	0.79
Admit type - non-elective	2.43 (1.66 - 3.56)	<0.001
Hospital LOS	1.02 (1 - 1.04)	0.14
Total number of medications	1.02 (1 - 1.04)	0.1
DM	0.99 (0.63 - 1.54)	0.954
Hypertension	0.97 (0.83 - 1.13)	0.708
Dementia	0.67 (0.41 - 1.07)	0.095
Marital status - Married/partner	0.93 (0.68 - 1.29)	0.678
Number of hospitalizations previous 12 months	1.37 (1.26 - 1.49)	<0.001

Logistic Regression and propensity score

- P-value based on Z test statistic.

Hospitalization 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.74 (0.51 - 1.07)	0.111
Propensity score	0.16 (0.01 - 2.16)	0.168
Age	1.01 (0.99 - 1.02)	0.337
Female	0.89 (0.67 - 1.19)	0.438
Race - white	0.91 (0.7 - 1.19)	0.498
Admit type - non-elective	1.4 (0.91 - 2.14)	0.123
Hospital LOS	1.01 (0.99 - 1.03)	0.395
Total number of medications	1 (0.97 - 1.04)	0.924
DM	0.88 (0.56 - 1.37)	0.561
Hypertension	0.83 (0.59 - 1.17)	0.29
Dementia	0.58 (0.32 - 1.07)	0.08
Marital status - Married/partner	0.94 (0.72 - 1.22)	0.627
Number of hospitalizations previous 12 months	1.47 (1.27 - 1.71)	<0.001

ED 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.66 (0.46 - 0.93)	0.017
Propensity score	0.3 (0.03 - 3.5)	0.337
Age	1.02 (1 - 1.03)	0.024
Female	0.98 (0.75 - 1.29)	0.907
Race - white	1.04 (0.81 - 1.35)	0.738
Admit type - non-elective	2.19 (1.43 - 3.36)	<0.001
Hospital LOS	1.01 (0.99 - 1.03)	0.264
Total number of medications	1 (0.97 - 1.04)	0.804
DM	1 (0.66 - 1.51)	0.995
Hypertension	0.94 (0.69 - 1.29)	0.707
Dementia	0.63 (0.37 - 1.08)	0.092
Marital status - Married/partner	0.92 (0.72 - 1.17)	0.499
Number of hospitalizations previous 12 months	1.43 (1.24 - 1.66)	<0.001

Logistic Regression and propensity score

- P-value based on Z test statistic.

Hospitalization 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.74 (0.51 - 1.07)	0.111
Propensity score	0.16 (0.01 - 2.16)	0.168
Age	1.01 (0.99 - 1.02)	0.337
Female	0.89 (0.67 - 1.19)	0.438
Race - white	0.91 (0.7 - 1.19)	0.498
Admit type - non-elective	1.4 (0.91 - 2.14)	0.123
Hospital LOS	1.01 (0.99 - 1.03)	0.395
Total number of medications	1 (0.97 - 1.04)	0.924
DM	0.88 (0.56 - 1.37)	0.561
Hypertension	0.83 (0.59 - 1.17)	0.29
Dementia	0.58 (0.32 - 1.07)	0.08
Marital status - Married/partner	0.94 (0.72 - 1.22)	0.627
Number of hospitalizations previous 12 months	1.47 (1.27 - 1.71)	<0.001

ED 60 days post-intervention

Variable	OR (95% CI)	p-value
Intervention	0.66 (0.46 - 0.93)	0.017
Propensity score	0.3 (0.03 - 3.5)	0.337
Age	1.02 (1 - 1.03)	0.024
Female	0.98 (0.75 - 1.29)	0.907
Race - white	1.04 (0.81 - 1.35)	0.738
Admit type - non-elective	2.19 (1.43 - 3.36)	<0.001
Hospital LOS	1.01 (0.99 - 1.03)	0.264
Total number of medications	1 (0.97 - 1.04)	0.804
DM	1 (0.66 - 1.51)	0.995
Hypertension	0.94 (0.69 - 1.29)	0.707
Dementia	0.63 (0.37 - 1.08)	0.092
Marital status - Married/partner	0.92 (0.72 - 1.17)	0.499
Number of hospitalizations previous 12 months	1.43 (1.24 - 1.66)	<0.001

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Chapter VI. Conclusion

6.1 Review of Study Results

The studies in this dissertation evaluated two care transition programs at UCLA Health that aimed to improve outcomes for patients following transitions between (1) the hospital and home, and (2) the post-acute care setting and home. Both programs leveraged an existing UCLA Health program that embeds clinical pharmacists in team-based care models in the primary care setting. The results from the dissertation studies suggest that clinical pharmacist-driven programs that focus on medication management (i.e., reducing medication errors, simplifying medication regimens, and improving patient medication adherence), and are rooted in the primary care setting, can be effective in reducing inpatient utilization following patient discharge to home.

The following table summarizes the study periods, study populations, process and outcome measures, analytic approaches, and results for the three studies discussed in the previous chapters. Results from the HomeMeds utilization evaluation show that participating in the program was associated with significantly lower predicted probabilities of readmission after 30, 60, and 90 days, and a significantly lower predicted probability of an ED visit within 30 days. Results from the HomeMeds qualitative evaluation, which followed the quantitative evaluation and attempted to elucidate the potential pathways by which the clinical pharmacists contributed to the observed reduction in utilization, revealed that a wide range of medication discrepancies and medication-related problems were identified by the clinical pharmacists. The study also showed how the clinical pharmacists were well-positioned to address the problems by using the Epic electronic medical record (EMR) and effectively communicate recommended changes to the patient's primary care provider (PCP). Lastly, results from the evaluation of the

post-acute care transitions pilot program showed that receiving the intervention was associated with a significantly lower likelihood of a patient being readmitted to the hospital within 60 days.

Table 6-1: Summary of Results

	HomeMeds-Quantitative	HomeMeds-Qualitative	MyMEDS SNF
Study period	July 2014 - December 2016	July 2014 - December 2016	March 2015 – April 2016
Study population	494 intervention patients, 2,470 matched-control patients	100 randomly selected from 494 HomeMeds intervention patients	300 intervention patients, 1409 control patients
Measures	30, 60, 90-day readmissions 30-day ED visits	13 categories (e.g., potential drug-drug interactions, problematic Beers medications)	60-day readmissions 60-day ED visits
Statistical Analysis	Multivariate logistic regression with propensity-matched control group	Qualitative chart review, coding scheme with template	GEE logistic regression with propensity score covariate adjustment
Results	30-day readmission predicted probability 10.6% vs. 21.4%, intervention vs. control, p-value<0.001.	Discrepancies between EMR and HomeMeds list (83/100); patient taking medications differently than prescribed (52/100);	60-day readmissions: OR 0.73 (CI 0.55 - 0.97), P-Value 0.031 60-day ED visits: OR 0.78 (CI 0.35 - 1.74), P-Value 0.537

6.2 Considerations for Investment in Medication Management during Care Transitions

While the literature investigating hospital readmissions shows that numerous factors contribute to this endpoint, our findings suggest that medication-related problems may play a disproportionate role in poor outcomes that lead to subsequent utilization. Our findings support the hypothesis that clinical pharmacists have the potential to decrease the risk of poor outcomes following care transitions, particularly for older, home-bound adults who have multiple comorbidities and who are taking multiple medications. It is important to emphasize that the clinical pharmacists in these interventions were embedded in the primary care system, had full access to patients' information through the EMR, and were operating within an environment where they could seamlessly communicate with patients' PCPs. This helped to facilitate care continuity when patients transitioned across care settings. Health system workflow redesign that

enables the use of the EMR and full access to patient data and the patient's PCP should therefore be a consideration and priority for health systems that pursue these types of care transition programs.

6.3 Contributions to the Care Transitions Literature and Future Research

The studies in this dissertation contribute to the current care transitions literature by testing the interventions in a large, non-integrated, academic primary care network, and by deploying the interventions in real-world settings as opposed to highly-controlled randomized trials. This may increase the external validity of our findings. These interventions also serve as feasibility studies with HomeMeds demonstrating how health systems can partner effectively with community-based organizations to deploy potentially lower-cost care models, and with the SNF pilot demonstrating how health systems can facilitate integration across the care continuum. If these care transition models are more widely disseminated, future studies may include multi-center research studies that evaluate both outcomes and costs.

In the broader context of reducing hospital readmissions and improving outcomes following care transitions, Patient-Centered Outcomes Research Institute (PCORI)-type trials that test interventions focusing on medication accuracy, and using clinical pharmacists embedded in primary care practices versus other hypothesized ways by which to reduce readmissions, will also be important. Future studies might also include the use of predictive models that draw upon clinical, demographic, and socioeconomic data to identify patients who are at high risk for readmission and who are most likely to benefit from interventions similar to those evaluated here. Advances in health system-based predictive analytics and machine learning can potentially facilitate the use of such models.