# Evaluation of the Impact of Comprehensive Medication Management Services Delivered Posthospitalization on Readmissions and Emergency Department Visits

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## ABSTRACT

**BACKGROUND:** The impact of providing cognitive pharmacy services following hospital discharge has been studied with various results. This study is specifically focused on comprehensive medication management services delivered postdischarge in an interprofessional team environment to patients aged >65 years.

**OBJECTIVE:** To determine if delivery of comprehensive medication management services postdischarge will prevent hospital readmissions or emergency department visits within 6 months following discharge in patients aged >65 years. Secondary endpoints included 30-day and 60-day postdischarge events.

**METHODS:** This was a prospective group matched-controlled study of patients aged >65 years with selected diagnoses identified as high risk for readmission. The intervention group received comprehensive medication management that was provided face-to-face in the patient's primary care clinic within 2 weeks of discharge.

**RESULTS:** No statistically significant difference was found between intervention and control groups in hospital readmissions or emergency department visits at 30 days, 60 days, or 6 months after discharge. No statistically significant difference was seen in mortality between groups.

**CONCLUSIONS:** Provision of comprehensive medication management services did not reduce emergency department visits or readmissions in this study. This study was limited by multiple other changes occurring in the health system during the time of this study that potentially confounded results. In addition, the study may have been too small to detect a difference.


*J Manag Care Pharm.* 2014;20(9):886-93



### What is already known about this subject

- Hospital readmissions are an important target to reduce health care costs.
- Studies show that pharmacists can contribute to reducing hospital readmissions, but not all published studies are positive.
- The type of pharmacist interventions studied ranges from phone calls to home visits from pharmacists postdischarge.

### What this study adds

- This study found no difference in hospital readmissions or emergency department visits between subjects receiving comprehensive medication management services or standard care.
- Concurrent changes in the health care system directed at readmission reduction may have confounded findings.
- The design, recognized limitations, and findings may help optimize study design in future research on the impact of pharmacist services on hospital readmission.

There is a large body of literature documenting the significance of drug-related adverse events that occur after a patient is discharged from the hospital setting. One study demonstrated that 19% of hospital discharged patients experienced adverse events within 3 weeks following discharge, and 66% of those were drug related.[1] Additionally, a recent study found that 51% of hospital discharged patients had 1 or more clinically important medication errors, and 30.3% experienced adverse drug events during the first 30 days following discharge.[2]

In 2004, the estimated cost of unplanned rehospitalizations for Medicare patients was $17.4 billion. One study found that 19.6% of all Medicare patients were rehospitalized within 30 days, and 34% were rehospitalized within 90 days.[3]

Many studies have documented the positive impact that pharmacists can have on patient outcomes by providing comprehensive medication management services.[4-10] However, additional research is needed to determine the impact of these services on patient outcomes when they are provided after hospital admissions. Of special interest are specific patient populations that are at higher risk for clinically significant medication errors, including elderly patients who have health conditions associated with high rates of hospital readmission.[3]

Previous research has yielded conflicting results on the impact of pharmacists on hospital readmissions. Several studies have found a positive impact of pharmacist intervention on hospital readmissions and emergency department (ED) visits. In a British study, elderly patients received discharge

education and 2 home visits from a pharmacist. Significant results included an increase in compliance and decreases in general practitioner visits and hospital readmission rates.[11] A hospital discharge program in Boston, Massachusetts, which included a nurse discharge advocate and pharmacist phone call 2-4 days after discharge, resulted in a significant decrease in hospital readmissions and ED visits.[12] In Austin, Texas, Bellone et al. (2012) conducted a retrospective electronic record review of subjects with multiple medications and various chronic diseases and indicated a reduced readmission rate to the hospital for patients who received pharmaceutical care interventions within 60 days of hospital discharge compared with subjects with similar comorbidities who did not receive pharmaceutical interventions.[13]

However, a British study conducted in London found no difference in the utilization of health care services following collaboration between the discharging hospital pharmacist and the community pharmacist.[14] Increased hospital admissions and ED visits were found to be associated with pharmacists providing home visits following hospital discharge in patients greater than aged 80 years in another United Kingdom (UK) study.[15] A recent study utilized a 4-component intervention, which included pharmacist-assisted medication reconciliation, inpatient counseling by a pharmacist, provision of adherence aids, and individualized telephone follow-up as needed when identified by a research coordinator. The research group concluded that pharmacist-delivered intervention did not significantly reduce important medication errors.[2] The UK studies may have minimal generalizability to the U.S. health care system, but these studies illustrate that pharmacist interventions have had mixed results in the current literature on reduction of hospital readmissions.

The current study differs from most of those previously described in the literature because it examines the impact of the pharmacist providing comprehensive medication management[16] in the clinic team environment, where a direct line of communication exists between the pharmacist and the physician or other prescriber. This service is designed to provide for direct communication between the pharmacist, the provider, and the patient through comprehensive medication management visits to the clinic and follow-up phone calls. This study was conducted to evaluate the impact of the provision of comprehensive medication management on health care service utilization, with an overall goal of reducing the costs associated with hospital readmission and ED visits in elderly patients following hospitalization. The study also collected data to improve understanding of the types of drug therapy problems encountered by elderly patients.

## Methods

Subjects for this study were patients with selected diagnoses discharged from a 380-bed hospital with a Level II trauma center. Patients who received the intervention were identified prospectively, and group matched controls were identified after intervention data were collected.

In order to identify the appropriate target population within this health system, a prestudy review of hospital discharges for the period from January 1, 2006, to December 31, 2006, for patients aged 65 years or older with a primary care provider in the local internal medicine or family medicine clinics affiliated with the hospital were analyzed to determine conditions with the highest rates of 6-month readmissions to a hospital or ED. It was decided to focus on patients aged 65 years or older, since these patients are more likely to be rehospitalized because of comorbidities. Based on this analysis, the following diagnostic groups were selected because they had the highest level of hospital and ED readmission rates, ranging from 31.4%-53.5%: heart failure, dysrhythmias, genitourinary conditions, ischemic heart disease, and digestive disorders.

The study was approved under expedited review by the institutional review boards at the University of Minnesota and Essentia Health.

### Subjects

Inclusion criteria for participation in the study were the following: aged 65 years or older and discharged from the hospital after being admitted for heart failure, ischemic heart disease, dysrhythmias, genitourinary conditions, or digestive disorders. In addition, subjects had to have a primary care provider in the local internal medicine or family medicine clinics affiliated with the hospital. Patients were excluded from both the intervention and control group if they had previously met with a clinical pharmacist as part of the health system's medication therapy management program, or if they were enrolled in the health system's heart failure or atrial fibrillation programs, where medication management is coordinated by specially trained staff, including pharmacists. Although these additional services are available within the health system, not all cardiology patients took advantage of the heart failure or atrial fibrillation programs. Therefore, the diagnosis codes were included to reach patients being managed outside of the specialty clinics for these conditions. Patients were also excluded if they were enrolled in another clinical trial, not legally responsible for their own health care decisions, enrolled in hospice, or resided in a nursing home.

The review of hospital discharges for the period from January 1, 2006, to December 31, 2006, identified 700 patients meeting study inclusion criteria and determined that 184 of those patients (26.29%) had hospital readmissions within 6 months of discharge. At the time of the initial study design, little data were published in this area, but 1 study showed an absolute reduction in readmissions from pharmacist inter-

vention of 30%.[11] Study investigators set a 40% decrease in 6-month hospital readmission as the primary goal of the study and calculated the required sample size to be 141 intervention and 282 control subjects to reach 80% power.

### Identification

Potential intervention group subjects were identified by staff from the health system's clinical trials office from among those patients meeting study inclusion/exclusion criteria and who were scheduled for discharge. When identified patients were available, clinical trials staff pre-obtained consent from the patients verbally and scheduled an initial medication management visit. Contacted patients who refused to participate were also excluded from the pool of potential controls. Patients who were not contacted for enrollment in the study intervention were included in the pool of potential controls. This included all patients discharged during all nonstaffed hours.

### Intervention Group

Potential intervention group subjects met with the pharmacist on the scheduled date, received a full review of the intervention, and signed a consent form. In addition to standard medical care, the intervention group received an initial comprehensive medication management visit following hospital discharge and prior to their hospital follow-up appointments with their primary care providers. Clinic standard of care calls for the primary care posthospitalization follow-up appointment to occur within 2 weeks of hospital discharge, whenever possible. Comprehensive medication management was delivered face-to-face as defined by the Patient Centered Primary Care Collaborative, which includes a comprehensive assessment of all of the patient's medication-related needs, development of a care plan, and follow-up.[16] Follow-up consisted of a phone call 4 weeks after the initial visit or a face-to-face follow-up visit within 1 month if subjects had 3 or more drug therapy problems identified by the pharmacist. The pharmacist worked with the primary care team to resolve all identified drug therapy problems.

### Control Group

Controls were group matched retrospectively to intervention patients in a 2:1 ratio. Matching strata included the following: sex (M, F); age group (65-75, 76+); Charlson Comorbidity Index (CCI; 0, 1, 2, and 3+ comorbidities)[17]; and number of medications at hospital discharge (< 10, 10-13, 14-19, and 20+). Intervention patients were identified in 51 of the possible 64 stratification levels. The identified control group received standard medical care with no comprehensive medication management provided.

### Measurement Endpoints

The primary outcomes were rates of nonscheduled all-cause hospital readmission and any ED visits for 6 months after the hospital discharge, regardless of whether the readmission was related to the index admission, as well as time to the first of each of these events. Any admissions occurring after an initial readmission were not included in the analysis. Secondary endpoints were rates of death and any adverse event (hospital readmission, ED visit, or death) for 6 months following hospital discharge, as well as time to these occurrences.

Health care events were identified from the electronic health records (EHR) of the health system for the 6 months following hospital discharge. Only events from days 15-183 after hospital discharge were included, corresponding with the health system goal of having posthospitalization primary care follow-up appointments occur within 2 weeks of hospital discharge. To minimize the number of health care events that would be missed because they occurred at outside (nonhealth system) facilities, subjects were required to have a primary care provider in the local internal medicine or family medicine clinics affiliated with the hospital. ED visits and hospital readmissions were identified using both health system hospital records and provider billing recorders for services provided at nonhealth system facilities. Any readmission that was scheduled or planned to occur (e.g., angioplasty procedure) was excluded. Mortality was also identified through a query of the health system's EHR.

### Statistical Analysis

All intervention subjects who received a comprehensive medication management assessment were included in the analysis, regardless of whether they were available for follow-up. The IBM SPSS Statistics 21 package was used for data analysis (SPSS, Inc., Chicago, IL).

Logistic regression was used to compare rates of any hospital readmission, any ED visits, death, and any adverse events in the 6 months following hospital discharge. Analysis of variance evaluated the number of hospital readmissions, ED visits, and combined medical outcomes (hospital readmission and/or ED visit). Cox regression was used to evaluate the time to the first of each of the following: hospital readmission, ED visit, death, and any adverse event. To control for the effect of systemwide program and policy changes, 6-month periods of patient hospital discharge, from July 1, 2008-December 31, 2008, to January 1, 2011-June 30, 2011 (6 time periods), were included as a covariate in all analyses.

## Results

### Baseline Characteristics

At hospital discharge, intervention and control group sex, age, CCI,[17] and number of discharge medications were comparable, which was in keeping with the stratified group-matching methodology (Table 1). However, the discharge period (6-month window) was significantly different for the 2 groups, with the smallest number of intervention subjects and the largest

**TABLE 1** Population Description: Intervention and Control Groups

| Description | Intervention (n = 135) | Control (n = 270) | Total (n = 405) |
|---|---|---|---|
| Sex–male, n (%) | 65 (48.1) | 130 (48.1) | 195 (48.1) |
| Age, mean (SD) | 75.9 (7.0) | 76.2 (7.9) | 76.1 (7.6) |
| CCI score, mean (SD) | 1.7 (1.8) | 1.9 (2.1) | 1.8 (2.0) |
| Discharge medications, mean (SD) | 14.8 (7.6) | 14.3 (7.6) | 14.4 (7.6) |
| Discharge period, n (%)[a] | | | |
| July 1-December 31, 2008 | 12 (8.9) | 62 (23.0) | 74 (18.3) |
| January 1-June 30, 2009 | 36 (26.7) | 55 (20.4) | 91 (22.5) |
| July 1-December 31, 2009 | 15 (11.1) | 44 (16.3) | 59 (14.6) |
| January 1-June 30, 2010 | 19 (14.1) | 33 (12.2) | 52 (12.8) |
| July 1-December 31, 2010 | 18 (13.3) | 40 (14.8) | 58 (14.3) |
| January 1-June 30, 2011 | 35 (25.9) | 36 (13.3) | 71 (17.5) |

[a]*Chi-square test P < 0.01.*
*CCI = Charlson Comorbidity Index; SD = standard deviation.*

**TABLE 2** Number and Types of Drug Therapy Problems Identified in the Intervention Group

| Drug Therapy Problem | Total Number | Average/Patient Mean (SD) |
|---|---|---|
| Unnecessary drug therapy | 70 | 0.52 (0.82) |
| Needs additional drug therapy | 88 | 0.65 (0.76) |
| Ineffective drug | 40 | 0.30 (0.52) |
| Dose too low | 38 | 0.28 (0.48) |
| Adverse drug reaction | 48 | 0.36 (0.62) |
| Dose too high | 40 | 0.30 (0.52) |
| Nonadherence | 69 | 0.51 (0.79) |
| Lab monitoring needed | 34 | 0.25 (0.44) |
| **Total** | **427** | **3.16 (1.63)** |

*SD = standard deviation.*

number of control subjects discharged from the hospital in the first period—from July 1, 2008, to December 31, 2008. This finding suggests the need to include discharge periods in subsequent analyses, as appropriate.

## Intervention Group

A total of 135 subjects were enrolled in the intervention group. The goal of 141 subjects was initially reached, but 6 subjects were excluded based on exclusion criteria during data analysis. In the intervention group, 42 subjects met the criteria for face-to-face follow-up. Eight subjects declined face-to-face follow-up, so a total of 34 subjects were seen for follow-up in the clinic. The remaining patients received a phone call follow-up from the pharmacist. Within the 135 intervention patients, a total of 427 drug therapy problems were identified and resolved, for an average of 3.16 drug (median and mode = 3.0) therapy problems per patient (see Table 2).

## Hospital Readmissions

No significant intervention/control difference was found when evaluating the simple question of whether patients had any hospital readmissions during the 6 months following hospital discharge, adjusted for the 6-month period in which the patient was discharged (Table 3).

Because the initial intervention occurred at about 2 weeks after the index hospitalization discharge, this study was designed to assess the occurrence of events 2 weeks or more after index hospital discharge, and it was not designed nor powered to evaluate 30-day or 60-day readmissions. As can be seen in Table 3, although the mean number of hospital readmissions in the intervention group was less than that of the control group through 60 days, this difference was not statistically significant, and the observed power was relatively low. The same is true when evaluating the adjusted odds of any hospital readmission—although the rates among the intervention group through 60 days are smaller than that of the control group, the rates are relatively small among both groups, and the differences are not statistically significant.

Alhough the number of hospital readmissions during the 6 months following hospital discharge decreased significantly with discharge period, $P < 0.05$, there was no significant intervention/control difference in the number of readmissions (Table 4).

## Emergency Department Visits

No significant intervention/control difference was found when evaluating the simple question of whether patients had any ED visits during the 6 months following hospital discharge, adjusted for the 6-month period in which the patient was discharged (Table 3). There was also no significant intervention/control difference in the number of ED visits during the 6-month period following hospital discharge (Table 4).

## Combined Medical Encounters, Mortality, and Adverse Events

The number of combined medical encounters (hospital readmission and/or ED visit) during the 6 months following hospital discharge decreased significantly with time (discharge period), $P < 0.05$, but there was no significant intervention/control difference in the number of encounters (Table 4).

No significant intervention/control difference was found when evaluating the simple question of all-cause mortality during the 6 months following hospital discharge, adjusted for the 6-month period in which the patient was diagnosed (Table 3). There was a lower mortality rate in the intervention group than the control group (3% vs. 5.6%), but it was not statistically significant (odds ratio [OR] = 0.587, 95% confidence interval [CI] = 0.188-1.826; Table 3, Figure 1).

**TABLE 3** Logistic Regression: Any Occurrence of Medical Outcomes Following Index Hospitalization Discharge

| | Intervention | | Control | | | 95% CI | |
|---|---|---|---|---|---|---|---|
| Any Occurrence | N | n (%) | N | n (%) | OR[a] | LL | UL |
| **Hospital readmissions[b]** | | | | | | | |
| 15-183 days | 134 | 30 (22.4) | 262 | 64 (24.4) | 0.958 | 0.580 | 1.582 |
| 15-60 days | 134 | 10 (7.5) | 265 | 29 (10.9) | 0.678 | 0.318 | 1.449 |
| 15-45 days | 134 | 7 (5.2) | 265 | 23 (8.7) | 0.592 | 0.245 | 1.429 |
| 15-30 days | 134 | 4 (3.0) | 268 | 15 (5.6) | 0.510 | 0.164 | 1.584 |
| **ED visits[b]** | | | | | | | |
| 15-183 days | 133 | 36 (27.1) | 258 | 62 (24.0) | 1.268 | 0.779 | 2.062 |
| 15-60 days | 134 | 10 (7.5) | 262 | 21 (8.0) | 0.949 | 0.430 | 2.098 |
| 15-45 days | 134 | 4 (3.0) | 263 | 16 (6.1) | 0.464 | 0.150 | 1.430 |
| 15-30 days | 134 | 1 (0.7) | 266 | 9 (3.4) | 0.207 | 0.026 | 1.671 |
| **Death** | | | | | | | |
| 15-183 days | 135 | 4 (3.0) | 270 | 15 (5.6) | 0.587 | 0.188 | 1.826 |
| 15-60 days | 135 | 1 (0.7) | 270 | 9 (3.3) | 0.266 | 0.028 | 1.821 |
| 15-45 days | 134 | 1 (0.7) | 270 | 8 (3.0) | 0.255 | 0.031 | 2.088 |
| 15-30 days | 134 | 1 (0.07) | 270 | 4 (1.5) | 0.524 | 0.057 | 4.829 |
| **Adverse events[c]** | | | | | | | |
| 15-183 days[d] | 135 | 44 (32.6) | 270 | 97 (35.9) | 0.931 | 0.596 | 1.453 |
| 15-60 days | 135 | 17 (12.6) | 270 | 43 (15.9) | 0.779 | 0.423 | 1.435 |
| 15-45 days | 135 | 10 (7.4) | 270 | 35 (13.0) | 0.547 | 0.260 | 1.150 |
| 15-30 days | 135 | 5 (3.7) | 270 | 20 (7.4) | 0.472 | 0.172 | 1.299 |

[a]*Adjusted for discharge period.*
[b]*Subjects with no prior events are censored upon death.*
[c]*ED visits, hospital readmissions, and/or death.*
[d]*Discharge period statistically significant at P<0.05.*
*CI=confidence interval; ED=emergency department; LL=lower limit; OR=odds ratio; UL=upper limit.*

While the odds of having any adverse events decreased over time (OR=0.875 [per 6-month period], 95% CI=0.776-0.986 [per 6-month period]), no significant intervention/control difference was found when adjusted for the 6-month period in which the patient was diagnosed (Table 4).

## Discussion

In recent years, several new models have been tested to reduce hospital readmissions. These models are programs highly integrated into health systems with multiple health care providers involved.[18] The comprehensive medication management services provided in the intervention group of this study were done so in collaboration with the interprofessional health care team. The recent literature shows that a team-based approach is required in order to impact hospital readmissions. In this study, the single intervention of comprehensive medication management services is analyzed, and there was no statistically significant difference demonstrated in primary outcomes of hospital readmissions or ED visits in 6 months, or death.

Although not statistically significant, the decrease in mortality of 41% in the intervention group is notable (OR=0.587, 95% CI=0.188-1.826). This study was not powered to look at mortality, so it would be difficult to achieve statistical significance with this outcome. However, this difference in mortality between the control and intervention groups is worthy of further study.

Due to the extended time of the study, and that both intervention and control groups saw improvement in medical events over time, it is challenging to narrow the analysis to the pharmacist services intervention. At the time of this study, the participating health system was going through ongoing quality improvement initiatives, and the impact of the pharmacist may have been masked by other changes of greater magnitude. Specifically, the overall health system was changing to achieve the goal of becoming an accountable care organization. Reducing 30-day hospital readmissions became an important goal, and initiatives such as the implementation of care coordinators, follow-up hospitalization phone calls, adding pharmacists to the ED, and a single electronic medical record across inpatient and outpatient settings were completed. The multiple layers of changes occurring during this time frame could not have been predicted at the initiation of the study and were unable to be controlled for in this trial. Additionally, many patients with heart failure and atrial fibrillation were excluded because they were enrolled in standardized interprofessional care programs already developed to reduce rehospitalizations. It is possible that by excluding this group, the number of avoidable hospital readmissions in both study groups was further reduced.

**TABLE 4** Analysis of Variance: Number of Events Following Index Hospitalization Discharge

| Number of Events | Intervention N | Intervention Mean (SD) | Control N | Control Mean (SD) | *P* Value[a] | Observed Power[b] |
|---|---|---|---|---|---|---|
| **Hospital readmissions[c]** | | | | | | |
| 15-183 days[d] | 134 | 0.34 (0.79) | 262 | 0.34 (0.73) | 0.728 | 0.064 |
| 15-60 days | 134 | 0.07 (0.26) | 265 | 0.13 (0.39) | 0.199 | 0.250 |
| 15-45 days | 134 | 0.05 (0.22) | 265 | 0.09 (0.32) | 0.209 | 0.241 |
| 15-30 days | 134 | 0.03 (0.17) | 268 | 0.06 (0.25) | 0.228 | 0.226 |
| **ED visits[c]** | | | | | | |
| 15-183 days | 133 | 0.44 (1.03) | 258 | 0.41 (0.94) | 0.641 | 0.075 |
| 15-60 days | 134 | 0.08 (0.30) | 262 | 0.11 (0.40) | 0.521 | 0.098 |
| 15-45 days | 134 | 0.04 (0.23) | 263 | 0.08 (0.33) | 0.196 | 0.252 |
| 15-30 days | 134 | 0.01 (0.09) | 266 | 0.04 (0.21) | 0.118 | 0.346 |
| **Medical encounters[e]** | | | | | | |
| 15-183 days[d] | 134 | 0.57 (1.25) | 262 | 0.56 (1.03) | 0.682 | 0.069 |
| 15-60 days | 134 | 0.13 (0.38) | 266 | 0.19 (0.50) | 0.317 | 0.170 |
| 15-45 days | 134 | 0.07 (0.29) | 266 | 0.14 (0.40) | 0.125 | 0.335 |
| 15-30 days | 134 | 0.03 (0.17) | 268 | 0.07 (0.27) | 0.115 | 0.350 |

[a]*Adjusted for discharge period.*
[b]*Computed at* $\alpha = 0.05$.
[c]*Subjects with no prior events are censored upon death.*
[d]*Discharge period statistically significant at* $P < 0.05$.
[e]*Combined hospital readmissions and/or ED visits; hospital admission from the ED = 1 encounter.*
*ED = emergency department; SD = standard deviation.*

Although the comprehensive medication management services provided in this study did not reduce hospital readmissions or ED visits over 6 months, it is possible that these outcomes were not sensitive enough to measure the impact of the benefit of these services in this small study. Other studies have consistently seen the benefits of pharmacist interventions on markers of chronic disease management,[4-10] long-term cost of care,[5,7,8] and patient satisfaction in the outpatient setting.[9,10] The impact of pharmacist intervention delivered postdischarge on health system utilization has not had a consistent response in the literature.[11-15,18] This may be due to the variability in the types of pharmacist intervention provided, the cultural climate of the health system being studied, or many other factors. One possible reason for this is that the pharmacist plays an important role, but other team members, such as care coordinators and nurse educators, also need to be added to the patient's care team to have a more significant impact in reducing hospital readmissions. Some of the largest decreases in health system utilization in the postdischarge period described in the literature are from interventions involving an interprofessional team with care coordination and other health care providers, including pharmacists.[12,18] In this study, pharmacists providing the care were integral members of the primary care team, with well-developed collaborative relationships with the providers. It is believed that this interprofessional approach likely contributed to the positive impact on improvement in mortality.

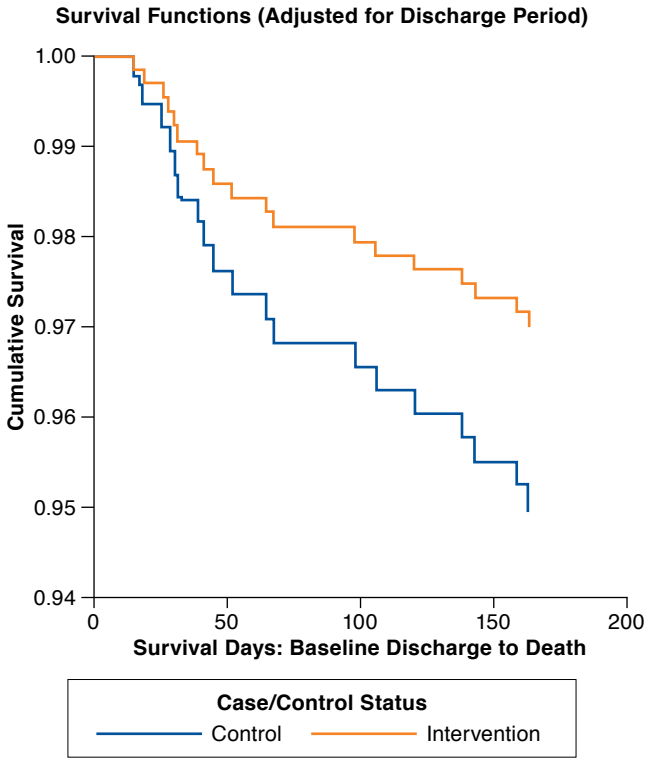
In a recent study, van Walraven and Forster (2013) described the statistical complexity of demonstrating statistical significant reductions in hospital readmissions.[19] They estimated that 23% of all hospital readmissions within 30 days are actually avoidable readmissions. According to van Walraven and Forster, in order to have a 20% reduction in total hospital readmissions, a 91% reduction in potentially avoidable readmissions would be needed.[19] This statistical analysis illustrates that finding an intervention that can decrease hospital readmissions in a statistically significant manner is a large challenge for clinicians and researchers.

In scientific literature, there has been a lot of focus in recent years on the potential for publication bias, particularly that negative studies may go unpublished, leaving important data out of the public eye.[20-21] Although criticism is primarily focused specific medical interventions, such as drugs or procedures, the same critique can apply to analysis of care models in today's health care system. Although this study did not see a statistically significant reduction in primary outcomes, there is much to be learned from this experience in study design, recognition of variables, and the impact of a pharmacist on patient outcomes.

## Limitations

There are several limitations to this study. There may be bias in our groups, since the subjects recruited for the control group were contacted during normal business hours. Potential subjects being discharged on evening and weekends were not contacted. It is not known if differences may exist between these patient populations that may have biased results and

**FIGURE 1** Survival Days Postdischarge to Death




been undetectable in included variables. Since all of the data were collected with the regional health system data, any hospital readmissions and ED that occurred outside of the system are not included. This limitation is expected to have impacted both the intervention and control groups, but the data are not available. The precalculated power indicated that 141 subjects would be needed to reach statistical significance, and due to exclusions identified during data analysis, the final intervention group was below the required number at 135. Therefore, the study was underpowered to see a 40% decrease in hospital admissions and ED visits, and as already described, the 40% decrease in hospital admissions and ED visits is likely more than what can be reasonably achieved.

## Conclusions

The provision of comprehensive medication management services by pharmacists following hospital discharge did not reduce ED visits or hospital readmissions within 6 months after discharge. No statistically significant difference was seen in mortality between groups. This study was limited by multiple other changes occurring in the health system during the time of this study, potentially confounding results. In addition, the study may have been too small to detect a difference.

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### DISCLOSURES

The authors received funding for this study from Peters Institute for Pharmaceutical Care and Essentia Health Research Institute.

Study concept and design were contributed by Westberg, assisted by Renier and Gessert. Swanoski and Renier collected the data, which were interpreted primarily by Renier with help from the other authors. The manuscript was written and revised by Westberg and Renier, assisted by Swanoski and Gessert.

### ACKNOWLEDGMENTS

For her instrumental work in data collection for this study, the authors would like to acknowledge Jeanette Palcher, Informatics Analyst, Essentia Institute of Rural Health, Essentia Health, Duluth, Minnesota.

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