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Effect of the population health inpatient Medicare Advantage pharmacist intervention on hospital readmissions: A quasi-experimental controlled study

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Plain language summary

This study looked at pharmacist care around hospital discharge for patients with Medicare Advantage insurance. We compared patients who got pharmacist care with those who did not get it. This study found that pharmacist care had no effect on readmissions. The differences between groups were a limitation in this study.

Implications for managed care pharmacy

This study evaluated the effect of a multicomponent intervention delivered by a transitions-of-care pharmacist prior to hospital discharge in addition to standard care, which included a pharmacist-led, postdischarge follow-up phone call. We detected no significant difference in unplanned 30-day same-hospital readmissions between the intervention and standard care. Future studies seeking to evaluate inpatient pharmacist-led interventions should be designed to minimize the risk of selection bias, including differential assignment to study groups based on the day of hospital discharge.

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ABSTRACT

BACKGROUND: The population health inpatient Medicare Advantage pharmacist (PHIMAP) intervention is a pharmacist-led, transitions-of-care intervention that aims to reduce hospital readmissions among Medicare Advantage beneficiaries. PHIMAP includes inpatient pharmacist participation in interdisciplinary rounds, admission and discharge medication reconciliation, pharmacy staff delivery of discharge medications to the bedside, personalized discharge medication lists and counseling, and communication with outpatient pharmacists through an electronic health record.

OBJECTIVE: To evaluate the effect of the PHIMAP intervention on unplanned 30-day same-hospital readmissions among Medicare Advantage patients.

METHODS: Those included were patients admitted to a large urban academic medical center between May 2018 and March 2020 who had a Medicare Advantage plan and were aged at least 18 years. A 2-group, quasi-experimental design was utilized. Control patients received the usual care, which included a best possible medication history and a postdischarge phone call. A multivariable logistic regression model was estimated to predict unplanned 30-day same-hospital readmissions. This study was a Hypothesis Evaluating Treatment Effectiveness study.

RESULTS: In total, 884 patients were included. The majority were White (59.0%), non-Hispanic (87.7%), English speaking (90.5%), and older adults (median age, 75 years; interquartile range, 70-83 years). We detected no statistically significant association between the PHIMAP intervention and unplanned 30-day same-hospital readmissions (odds ratio [OR] = 0.91, 95% CI = 0.56-1.52). After adjusting for patient demographics and clinical covariates, significant predictors of 30-day readmissions included the number of emergency department/inpatient visits within 180 days prior

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to index admission (OR=1.40, 95% CI=1.11-1.77); discharge to a
post–acute care facility, such as an inpatient rehabilitation facility,
long-term acute care facility, or skilled nursing facility (OR=1.69, 95%
CI=1.06-2.66); hospital length of stay in days (OR=1.04, 95% CI=1.01-
1.07); and the Agency for Healthcare Research and Quality Elixhauser
Comorbidity Index score (OR=1.01, 95% CI=1.01-1.02).

CONCLUSIONS: Significant predictors of readmissions among
Medicare Advantage beneficiaries were consistent with greater ill-
ness severity, including a recent history of prior hospital utilization,
a discharge to post–acute care facility (vs home), a longer length
of hospital stay, and a higher comorbidity burden. Although we
detected no statistically significant association between PHIMAP
and unplanned 30-day same-hospital readmissions, differences
in study group assignment based on the day of hospital discharge
(weekend vs weekday) was a noted limitation of this study. Future
studies of inpatient pharmacist-led interventions should plan to
minimize the risk of selection bias due to differences in the time of
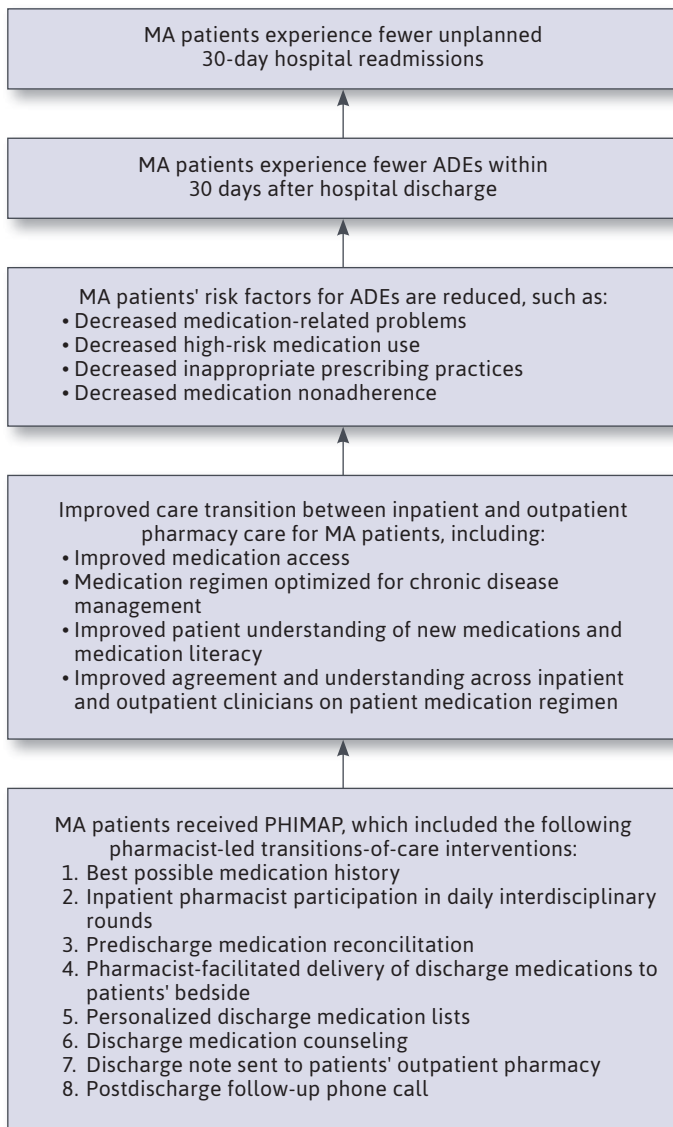patient discharge.

In the United States, Medicare Advantage (MA) insurance
plans are privately managed and capitated health plans that
offer an alternative to the Medicare fee-for-service plan
managed by the federal government, also known as tradi-
tional Medicare. The Medicare population includes older
adults (aged 65 years and older) as well as younger adults
with disabilities, end-stage renal disease, and amyotrophic
lateral sclerosis.[1] Approximately 34% of the Medicare popu-
lation is enrolled in an MA plan.[1] A 2019 study of a nationally
representative sample of MA beneficiaries showed that
MA beneficiaries were more likely to be readmitted within
30 days of hospital discharge compared with traditional
Medicare fee-for-service beneficiaries.[2] Of note, the study
adjusted for readmission risk attributable to patient age,
sex, race, ethnicity, income, education, comorbidity bur-
den, and dual Medicare/Medicaid coverage.[2] Compared
with fee-for-service plans, one reason that MA beneficiaries
experience higher risk-adjusted readmission rates may be
due to more frequent prescription of high-risk medications
associated with adverse drug events (ADEs).[3] Approximately
17%-21% of MA beneficiaries are prescribed at least one
high-risk medication associated with ADEs that increase
the risk of readmission.[3,4] Given the MA population's higher
risk-adjusted readmission rate and use of high-risk medica-
tions as a contributing factor to readmissions, interventions
are needed to reduce medication-related hospital readmis-
sions that affect the MA population.[2,3]

Medication-related hospital readmissions are common,
costly, and more prevalent among older patients.[5,6] Yet, the
majority of 30-day readmissions due to ADEs are preventable.[7]

Previous studies have shown that pharmacist-led inter-
ventions can reduce risk factors for medication-related
hospital readmissions in the MA population, including
high-risk medication use,[8] medication-related problems,[9,10]
poor medication adherence,[11,12] and inappropriate prescrib-
ing practices for at-risk subgroups, such as patients with
diabetes.[13] Prior studies have also investigated the effect
of pharmacist-led interventions delivered during home
visits to improve transitions of care and to reduce 30-day
readmissions in the MA population, although the results
have been mixed.[14,15]

The objective of this study was to evaluate the effect of
the population health inpatient MA pharmacist (PHIMAP)
intervention on unplanned 30-day readmissions among MA
beneficiaries. This study took advantage of a unique context
in which pharmacist-led postdischarge follow-up phone
calls had already been implemented as standard care in the
study setting for MA patients. Pharmacist-led postdischarge
follow-up phone calls have been shown to reduce prevent-
able ADEs within 30 days of hospital discharge.[16] Therefore,
this study seeks to contribute to the transitions-of-care
literature by exploring the potential benefits of adding
pharmacist-led transitions-of-care interventions prior to
hospital discharge (herein, referred to as the PHIMAP
intervention) in addition to standard care that included a
pharmacist-led postdischarge follow-up phone call.

Figure 1 illustrates the intervention's hypothesized
theory of change developed through discussion among the
authors, including pharmacists with expertise in transitions
of care who had developed and implemented the interven-
tion as part of a quality improvement initiative. The Ideal
Transitions in Care (ITC) framework was used to explain
potential mechanisms of change that the intervention
targets to reduce readmissions, including pharmacist-led
discharge counseling and discharge medication recon-
ciliation to address the medication safety domain of the
ITC framework.[17] In addition to medication safety, the
ITC framework includes 9 other domains associated with
readmission reduction: (1) the complete communication
of information; (2) the availability, timeliness, clarity, and
organization of information; (3) the education of patients to
promote self-management; (4) the monitoring and manag-
ing of symptoms after discharge; (5) the help of social and
community supports; (6) advanced care planning; (7) the
coordination of care among team members; (8) discharge
planning; and (9) follow-up with outpatient providers.[17,18] In
this Hypothesis Evaluating Treatment Effectiveness study,
we hypothesized that the PHIMAP intervention would
reduce 30-day readmissions among MA beneficiaries.[19]

FIGURE 1 Theory of Change for the PHIMAP Intervention

MA patients experience fewer unplanned 30-day hospital readmissions

MA patients experience fewer ADEs within 30 days after hospital discharge

MA patients' risk factors for ADEs are reduced, such as:
• Decreased medication-related problems
• Decreased high-risk medication use
• Decreased inappropriate prescribing practices
• Decreased medication nonadherence

Improved care transition between inpatient and outpatient pharmacy care for MA patients, including:
• Improved medication access
• Medication regimen optimized for chronic disease management
• Improved patient understanding of new medications and medication literacy
• Improved agreement and understanding across inpatient and outpatient clinicians on patient medication regimen

MA patients received PHIMAP, which included the following pharmacist-led transitions-of-care interventions:
1. Best possible medication history
2. Inpatient pharmacist participation in daily interdisciplinary rounds
3. Predischarge medication reconcilitation
4. Pharmacist-facilitated delivery of discharge medications to patients' bedside
5. Personalized discharge medication lists
6. Discharge medication counseling
7. Discharge note sent to patients' outpatient pharmacy
8. Postdischarge follow-up phone call

ADE = adverse drug event; MA = Medicare Advantage; PHIMAP = population health inpatient MA pharmacist.

Methods

The Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) were used to guide the reporting of this work.[20] An institutional review board (IRB) application was submitted to the IRB at Cedars-Sinai Medical Center in Los Angeles, California. The study received exemption from full IRB review as a quality improvement initiative. IRB staff reviewed and approved all procedures for retrospective data collection, management, and analyses.

STUDY SETTING

The quality improvement initiative was undertaken at a single, large, urban academic medical center: Cedars-Sinai Medical Center (Los Angeles, CA, USA). The medical center includes 886 licensed beds and more than 4,500 physicians and nurses on staff. In the 2019-2020 fiscal year, the medical center serviced 51,000 admissions, 119,000 emergency department visits, and 1,290,000 outpatient visits.[21] Housed under the medical center's organizational umbrella, the Cedars-Sinai Medical Delivery Network includes an integrated network of over 300 physicians providing inpatient and outpatient care to over 100,000 patients per year, as well as over 400 physicians in private practice serving the Los Angeles area.

STUDY DESIGN AND SAMPLE

The study utilized a 2-group, quasi-experimental design (Figure 2). The study sample included MA patients admitted to the medical center between May 2018 and March 2020. The inclusion criteria were (1) that the MA plan be served by the Cedars-Sinai Medical Delivery Network, (2) that the patients be aged at least 18 years, and (3) that the patients be registered as an index hospital admission under inpatient status during the study period. The exclusion criteria were (1) death during the index hospital admission; (2) a discharge location inconducive to the study of hospital readmissions, including discharge against medical advice, to hospice, to another state, or to another acute hospital unit; and (3) transplant patients who were already expected to receive transitions-of-care pharmacist interventions at the study site.
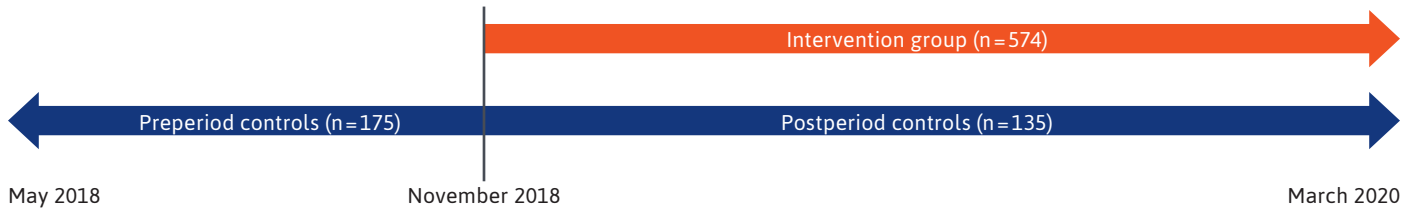
INTERVENTION

All control patients received the usual care. Prior to the implementation of PHIMAP, the usual care for MA patients at the study site included the following inpatient pharmacist-led interventions: (1) the best possible medication history conducted by a pharmacy technician or pharmacist for high-risk patients taking at least 10 prescription medications and (2) a postdischarge follow-up phone call made by outpatient pharmacists.

In addition to the usual care, PHIMAP added the following pharmacist-led intervention activities:
1. The best possible medication history conducted by a pharmacy technician or pharmacist for all MA patients receiving the PHIMAP intervention, regardless of the number of prescription medications taken prior to admission

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Overview of Quasi-Experimental Study Design With Nonrandom Assignment to Intervention and Control Groups

Intervention group (n = 574)

Preperiod controls (n = 175)

Postperiod controls (n = 135)

May 2018   November 2018   March 2020

2. Inpatient pharmacist participation in daily interdisciplinary rounds
3. Predischarge medication reconciliation
4. Pharmacist-facilitated delivery of discharge medications to the patient's bedside (in place of nurse facilitation)
5. The provision of a personalized discharge medication list prior to discharge
6. Discharge medication counseling
7. A discharge summary note sent to the patient's outpatient pharmacist through an electronic health record (EHR) (Epic Systems Corporation).

One full-time inpatient pharmacist, who had previously completed 1 year of residency training in transitions-of-care pharmacy, delivered the PHIMAP intervention on weekdays (Mondays through Fridays from 9:00 AM to 5:30 PM) starting in November 2018. Patients were assigned to the intervention group using a convenience sampling approach whereby patients received PHIMAP to the extent that the pharmacist had time available to deliver the intervention. Patients who met all inclusion criteria but did not receive the intervention were assigned to the control group.

OUTCOMES

The primary outcome of the study was unplanned 30-day same-hospital readmissions, operationally defined as readmission to the same hospital on an emergent or urgent basis occurring within 30 days after hospital discharge. The rationale for selecting the primary outcome was that a change in unplanned 30-day readmissions would be a strong motivator for hospital and health system leaders to financially invest in the intervention for long-term maintenance and sustainability. Hospital pharmacy leaders and pharmacists involved in the intervention's development, delivery, and administrative oversight were included on the study team and corroborated the rationale for primary outcome selection.

Readmissions on an elective basis were excluded using an indicator variable obtained from the EHR that categorizes each hospital admission as emergent, urgent, or elective. The indicator variable corresponds to inpatient data reporting requirements for the State of California's Department of Health Care Access and Information, which routinely makes aggregated hospital data available to the public.[22] Definitions of each hospital admission category follow the National Uniform Billing Committee's UB-04 Data Specifications Manual.[23]

STATISTICAL ANALYSIS

A multivariable logistic regression model was estimated to predict the binary outcome (yes/no) of unplanned 30-day same-hospital readmission. Predictor variables included study group (intervention or control); patient demographics, including age, sex, race, ethnicity, marital status, and language (English or non–English speaker); and clinical covariates, including the Agency for Healthcare Research and Quality Elixhauser Comorbidity Index (weighted for risk of readmission due to comorbidity burden with weighted scores ranging from −4 [lesser disease burden] to 229 [greater disease burden]),[24] number of outpatient medications prior to index hospital admission, number of same-hospital emergency department/inpatient visits within 180 days prior to index admission, length of hospital stay, discharge location (home or post–acute care facility, including inpatient rehabilitation facility, intermediate- or long-term care facility, or skilled nursing facility), and day of discharge (weekday or weekend). Data on patient demographics and clinical covariates were obtained retrospectively from the EHR. The potential for multicollinearity among predictor variables was examined through visual inspection of the covariance matrix and subsequent evaluation of formally derived measures (tolerance, variance inflation factor, eigenvalue, and condition index). Statistical modeling and model evaluation were performed using SAS version 9.4 (SAS Institute Inc.).

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| TABLE 1 | Patient Characteristics and Unadjusted Readmission Rates |

	Study group						Unadjusted P value
Characteristic	Preperiod control (n=175)		Postperiod control (n=135)		Intervention (n=574)		
Age, median (IQR), y	75	(71-85)	74	(69-80)	76	(70-83)	0.04
Sex, % (n)							
Female	58.3	(102)	52.6	(71)	54.5	(313)	0.57
Male	41.7	(73)	47.4	(64)	45.5	(261)	
Race, % (n)							
White	62.9	(110)	59.3	(80)	57.8	(332)	0.15
Black	20.6	(36)	31.1	(42)	27.7	(159)	
Asian	9.7	(17)	6.7	(9)	10.6	(61)	
Other	6.9	(12)	3.0	(4)	3.8	(22)	
Hispanic, % (n)	13.7	(24)	14.8	(20)	11.3	(65)	0.45
Non–English speaker, % (n)	11.4	(20)	11.1	(15)	8.5	(49)	0.41
Marital status, % (n)							
Married/partnered	38.3	(67)	48.9	(66)	39.7	(228)	0.14
Single	20.0	(35)	24.4	(33)	22.6	(130)	
Widowed	23.4	(41)	15.6	(21)	18.8	(108)	
Divorced/separated	18.3	(32)	11.1	(15)	18.8	(108)	
Elixhauser Index, median (IQR)	33	(15-59)*	25	(12-45)†	38	(20-58)*	<0.01[a]
Outpatient medications, median (IQR), n	11	(7-15)	10	(7-14)	12	(8-17)	<0.01
Prior visits,[b] median (IQR)	0	(0-0)*†	0	(0-0)*	0	(0-1)†	<0.01[a]
Length of stay, median (IQR), d	3	(2-6)	3	(2-5)	4	(2-6)	<0.01
Discharge location, % (n)							
Home	68.6	(120)	82.2	(111)	70.7	(406)	0.01
Facility[c]	31.4	(55)	17.8	(24)	29.3	(168)	
Weekday discharge, % (n)	75.4	(132)*	26.7	(36)†	97.2	(558)‡	<0.01[a]
Unadjusted outcomes							
30-day readmissions, % (n)	13.1	(23)	9.6	(13)	14.3	(82)	0.36

Rows without a common superscript symbol are statistically significantly different using Holm-adjusted P values for post hoc pairwise comparisons.[25]
[a]Adjusted P values less than 0.05.
[b]Includes inpatient and emergency department visits within 180 days prior to index hospital admission
[c]Includes discharge to skilled nursing facility, inpatient rehabilitation facility, and intermediate- or long-term care facility.
d=day; IQR=interquartile range; y=year.

Descriptive statistics and between-group comparisons of demographics and clinical covariates were obtained for the following groups: (1) intervention group; (2) preperiod controls, defined by an index hospital admission before PHIMAP implementation between May 2018 and October 2018; and (3) postperiod controls, defined by an index hospital admission after PHIMAP implementation between November 2018 and March 2020. Pearson chi-square tests of independence were used to compare groups on nominal categorical data, with post hoc pairwise z-test comparisons. Krusal-Wallis tests corrected for tied ranks were used to compare group medians, with post hoc Mann-Whitney U-tests for pairwise differences. The α level of significance for statistical testing was set at 0.05 with two-sided P values adjusted for multiple comparisons using the Holm sequential procedure.[25] Descriptive statistics and between-group comparisons were performed using SPSS Statistics version 24.0 (IBM).

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TABLE 2	Patient Characteristics and Unadjusted Readmission Rates Stratified by Day of Discharge				
Characteristic	**Weekday discharge (n=726)**		**Weekend discharge (n=158)**		**Unadjusted P value**
Age, median (IQR), y	76	(70-84)	75	(70-81)	0.14
Sex, % (n)					
Female	54.0	(392)	59.5	(94)	0.21
Male	46.0	(334)	40.5	(64)	
Race, % (n)					
White	59.6	(433)	56.3	(89)	0.83
Black	26.3	(191)	29.1	(46)	
Asian	9.9	(72)	9.5	(15)	
Other	4.1	(30)	5.1	(8)	
Hispanic, % (n)	88.3	(641)	84.8	(134)	0.23
Non–English speaker, % (n)	9.5	(69)	9.5	(15)	0.99
Marital status, % (n)					
Married/partnered	40.6	(295)	41.8	(66)	0.46
Single	21.9	(159)	24.7	(39)	
Widowed	19.0	(138)	20.3	(32)	
Divorced/separated	18.5	(134)	13.3	(21)	
Elixhauser Index, median (IQR)	36	(18-58)*	27	(12-49)†	<0.01[a]
Outpatient medications, median (IQR), n	8	(4-14)	8	(4-11)	0.03
Prior visits,[b] median (IQR)	0	(0-1)*	0	(0-0)†	<0.01[a]
Length of stay, median (IQR), d	4	(2-6)	3	(2-5)	0.12
Discharge location, % (n)					
Home	70.5	(512)	79.1	(125)	0.03
Facility[c]	29.5	(214)	20.9	(33)	
Unadjusted outcomes					
30-day readmissions, % (n)	14.5	(105)	8.2	(13)	0.04

Rows without a common superscript symbol are statistically significantly different using Holm-adjusted P values for post hoc pairwise comparisons.[25]

[a]*Adjusted P values less than 0.05.*

[b]*Includes inpatient and emergency department visits within 180 days prior to index hospital admission*

[c]*Includes discharge to skilled nursing facility, inpatient rehabilitation facility, and intermediate- or long-term care facility.*

d=day; IQR=interquartile range; y=year.

Results

SAMPLE CHARACTERISTICS

Table 1 shows patient demographics, clinical characteristics, and unadjusted 30-day unplanned readmission rates. In total, 884 patients were included in the study. Of these, 574 patients received the intervention, and 310 patients were assigned to the control group. Most of the patients were older adults (median age, 75 years; interquartile range [IQR]=70-83 years). The study sample was 55.0% female, 12.3% Hispanic, 9.5% non–English speakers, 59.0% White, 26.8% Black or African American, and 9.8% Asian.

Approximately 4% of the study sample was included in the race category of "Other," which included the following labels from the EHR: "American Indian or Alaska Native" (n=1), "Native Hawaiian or Pacific Islander" (n=4), and "Other" (n=33).

Missing data were observed for race and ethnicity. In total, 6 patients (0.7%) had an unknown race, and 6 patients (0.7%) had an unknown ethnicity. One patient had both an unknown race and ethnicity (0.1%). In preparation for multivariable modeling, missing data were input using the most frequent categorical value (mode imputation) and assumed to be missing at random.

After adjusting for multiple comparisons, patients in the preperiod control, postperiod control, and intervention groups did not differ significantly with respect to age, sex, race, ethnicity, language, marital status, number of outpatient medications, length of stay, or discharge location (Holm-adjusted P>0.05). In contrast, study groups were significantly different in the following ways. Compared with the postperiod controls, patients in the intervention group had a higher comorbidity burden (median Elixhauser Index score [IQR]=38 [20-58] vs 25 [12-45]; adjusted P<0.05); more emergency department/inpatient visits within 180 days prior to index admission (median [IQR]=0 [0-1] vs 0 [0-0]; adjusted P<0.05); and a longer length of hospital stay (median [IQR]=4 [2-6] days vs 3 [2-5] days; adjusted P<0.05). Furthermore, compared with postperiod controls, preperiod controls had a higher comorbidity burden (median Elixhauser Index score [IQR]=33 [15-59] vs 25 [12-45]; adjusted P<0.05).

Consistent with the intervention having been administered on weekdays, patients in the intervention group were nearly always discharged on a weekday (97.2%) and were more likely to be discharged

TABLE 3 Multivariable Logistic Regression Coefficients and Adjusted ORs Predicting Unplanned 30-Day Same-Hospital Readmissions (N=884)

Variable	Standardized coefficient, β	OR	95% CI for OR Lower limit	95% CI for OR Upper limit
Elixhauser Index score	0.20[a]	1.01	1.01	1.02
Prior visits,[b] count	0.14[c]	1.40	1.11	1.77
Discharge location (ref: home)				
Facility[d]	0.13[e]	1.69	1.06	2.66
Length of stay, d	0.11[e]	1.04	1.01	1.07
Outpatient medications, n	0.10	1.03	1.00	1.06
Language (ref: English)				
Non-English	0.09	1.77	0.74	4.03
Sex (ref: female)				
Male	0.08	1.34	0.86	2.08
Marital status (ref: married/partnered)				
Single	0.07	1.36	0.79	2.34
Divorced/separated	0.04	1.22	0.67	2.18
Widowed	−0.03	0.86	0.43	1.67
Study group (ref: control)				
Intervention	−0.03	0.91	0.56	1.52
Age, y	−0.05	0.99	0.97	1.01
Day of discharge (ref: weekday)				
Weekend	−0.08	0.68	0.32	1.36
Race (ref: White)				
Asian	−0.01	0.94	0.43	1.90
Other	−0.04	0.72	0.20	2.03
Black	−0.10	0.67	0.40	1.10
Ethnicity (ref: non-Hispanic)				
Hispanic	−0.15	0.43	0.18	1.03

[a]P values less than 0.001.
[b]Includes inpatient and emergency department visits within 180 days prior to index hospital admission.
[c]P values less than 0.01.
[d]Includes discharge to skilled nursing facility, inpatient rehabilitation facility, and intermediate- or long-term care facility.
[e]P values less than 0.05.
d=day; OR=odds ratio; ref=reference category; y=year.

Table 2 shows patient demographics, clinical characteristics, and unadjusted 30-day unplanned readmission rates stratified by the day of discharge. After adjusting for multiple comparisons, patients discharged on weekdays and weekends did not differ significantly with respect to age, sex, race, ethnicity, language, marital status, number of outpatient medications prior to index admission, length of stay, or discharge location (adjusted P>0.05). However, patients discharged on weekdays had a significantly higher comorbidity burden (median Elixhauser Index score [IQR]=36 [18-58] vs 27 [12-49]; adjusted P<0.05) and more emergency department/inpatient visits within 180 days prior to index admission (median [IQR]=0 [0-1] vs 0 [0-0]; adjusted P<0.05).

OUTCOME EVALUATION

Unadjusted 30-day same-hospital readmission rates were not significantly different between the intervention group (14.3%), preperiod controls (13.1%), or postperiod controls (9.6%) (P>0.05; Table 1). Further, unadjusted 30-day same-hospital readmission rates were not significantly different between patients who were discharged on weekdays compared with those who were discharged on weekends (14.5% vs 8.2%; adjusted P>0.05; Table 2).

In multivariable modeling, an examination of the covariance matrix showed no evidence of severe collinearity between predictor variables (tolerance <0.1, variance inflation factor <5, and eigenvalues close to 0 with a correspondingly large condition index). Hosmer and Lemeshow's goodness-of-fit test was nonsignificant (P>0.05), indicating a well-fitting model.[26] Second- and third-order interaction terms between study group, time period (preperiod vs postperiod), and day of discharge (weekday vs weekend) were tested in the model. All interaction terms were found to be nonsignificant (P>0.05) and dropped from the final model with no change in the significance or direction of model main effects.

Table 3 shows the standardized logistic regression coefficients and adjusted odds ratios (ORs) of unplanned 30-day same-hospital readmissions after controlling for patient demographics and clinical covariates. Nonsignificant predictors of 30-day readmissions included study group, age, sex, language, race, ethnicity, marital status, number of outpatient medications prior to index admission, and day of discharge (weekend vs weekday). Statistically significant predictors of 30-day readmissions included the number of emergency department/inpatient visits within 180 days prior to index admission (OR=1.40, 95% CI=1.11-1.77, P<0.01); discharge to a post–acute care facility (OR=1.69, 95% CI=1.06-2.66, P<0.05); length of stay in days (OR=1.04, 95% CI=1.01-1.07, P<0.05); and comorbidity burden

on a weekday compared with either the preperiod controls (75.4%) or postperiod controls (26.7%; adjusted P<0.05). Preperiod controls were more likely to have been discharged on a weekday compared with postperiod controls (adjusted P<0.05).

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measured using the Agency for Healthcare Research and Quality Elixhauser Index score (OR=1.01, 95% CI=1.01-1.02, P<0.001). After standardizing the regression coefficients, the Elixhauser Index score that indicates comorbidity burden was the strongest predictor of 30-day readmissions in this sample of MA patients (Table 3).

Discussion

Key findings of this study include the following observations. We observed no statistically significant effect of the PHIMAP intervention on unplanned 30-day same-hospital readmissions among MA beneficiaries. Significant predictors of 30-day readmissions included a higher comorbidity burden, greater number of emergency department/inpatient visits prior to index admission, longer length of stay, and discharge to a post–acute care facility. Findings from prior studies corroborate with our observed associations between patient-level readmission risk and (1) comorbidity burden, (2) prior hospital utilization, (3) length of stay, and (4) discharge to institutional settings, which are each indicative of greater illness severity.[27-31] Future studies are needed to examine if hospital readmissions in the MA population are associated with the quality of post–acute care, which this study did not assess.

We note that the following contextual elements may have interacted with the PHIMAP intervention and contributed to the intervention's insignificant effect on 30-day hospital readmissions. Patients in the control group notably received pharmacist-led interventions as part of the existing standard of care at the study site, including a best possible medication history and postdischarge follow-up phone call, which may have reduced the differences in readmission risk between the study groups. Further, the intervention was delivered solely on weekdays when pharmacists with transitions-of-care training were staffed at the study site. Consequently, patients who were discharged on the weekend were less likely to receive the intervention. We observed that patients assigned to the control group after PHIMAP implementation (ie, postperiod controls) were more likely to have been discharged on a weekend, had a lower comorbidity burden, and less prior hospital utilization than the intervention group, suggesting that the postperiod controls had a better health status on average and a lower readmission risk.

Differences in hospital care on the weekend may have also been a confounding factor. We found that unadjusted 30-day readmission rates were overall lower in patients who were discharged on weekends compared with patients who were discharged on weekdays (8.2% vs 14.5%, respectively; unadjusted P=0.04). After adjusting for multiple comparisons, patient demographics, and clinical characteristics, however, the day of discharge was not a significant predictor of readmissions. This observation contrasts with the meta-analysis of Chiu et al (2020), which found that risk-adjusted 30-day readmission rates were higher among patients discharged from US hospitals on weekends compared with weekdays, though high heterogeneity was observed among studies included in the meta-analysis.[32] Future studies of managed care pharmacy interventions that aim to reduce hospital readmissions for diverse patient populations should be carefully designed to minimize the potential impact of a "weekend effect" on differences in readmission rates between study groups.

Compared with the usual standard care, the PHIMAP intervention introduced new pharmacist-led interventions that were performed exclusively in an acute hospital setting. Burke et al's ITC framework posits that hospitals have minimal control over factors influencing their readmission rates through changes within their own walls.[17] To positively impact readmission rates, Burke et al suggest that hospitals should seek to establish novel community partnerships, for example, through interactions with provider networks in postacute, outpatient, and primary care settings.[17] Future studies of pharmacist-led interventions that aim to reduce readmissions among the MA population should consider incorporating novel partnerships with community providers to improve transitions in care.

LIMITATIONS

There are several limitations of this study, notably associated with its quasi-experimental design.[33] Factors limiting internal validity include nonrandomized assignment to study groups. The lack of randomization introduces selection bias, which we observed as differences between the intervention and control groups on potential confounding variables (Table 1).[34] We attempted to control for known potential confounders related to between-group differences in patient demographics and clinical covariates using multivariable statistical modeling, but unknown confounding variables may not have been accounted for.

Other potential sources of bias may have included misclassification of patients to the intervention or control groups. To minimize this source of bias, one co-author (J.W.), who is the study pharmacist who delivered the intervention, manually reviewed all patients' EHRs to confirm that group assignments were correctly labeled. This review for data quality assurance was completed prior to data analysis, which was performed independently by another author (A.T.N.). Additionally, because this study was being pursued following a quality improvement initiative that had previously been completed, we were unable to assess

intervention fidelity or whether deviations from the intended intervention had occurred.

Factors limiting external validity include the use of a single-site design, which limited generalizability to other settings with different characteristics. We were unable to include readmissions to other hospitals (ie, not Cedars-Sinai Medical Center) in our measurement of 30-day readmissions. Further, we did not measure other potentially important process outcomes or secondary outcomes, such as changes in high-risk medication use, inappropriate prescribing practices, medication adherence, medication errors, ADEs, or mortality. These may be more important indicators of the quality of care compared with readmissions, which is supported in part by the observation that reductions in hospital readmission rates have been associated with concerning increases in patient mortality rates.[35]

Conclusions

This study evaluated the effect of a multicomponent, transitions-of-care pharmacist intervention on unplanned 30-day same-hospital readmissions among MA beneficiaries. Although we confirmed known associations between illness severity and likelihood of readmission, we observed no significant effect of the PHIMAP intervention on 30-day readmissions. However, differences in the likelihood of study group assignment based on the day of hospital discharge (weekend vs weekday) may have introduced bias. Future studies seeking to evaluate the effects of managed care pharmacy interventions on hospital readmissions should be designed to minimize the risk of selection bias due to differences in the day of discharge.

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