

Post-Hospital Discharge Care: A Retrospective Cohort Study Exploring the Value of Pharmacist-Enhanced Care and Describing Medication-Related Problems

Emily M. Hawes, Nicole R. Pinelli, Kimberly A. Sanders, Andrew M. Lipshutz, Gretchen Tong, Lauren S. Sievers, Sarah Chao, Mark Gwynne

BACKGROUND Medication-related problems occur at high rates during care transitions. Evidence suggests that pharmacists are well-suited to identify and resolve medication-related problems during hospital admission and at discharge. Additional evidence is needed to understand the impact of face-to-face pharmacist visits in primary care after discharge. The purpose of the study was to describe medication-related problems found during face-to-face pharmacist visits in a medical home after hospital discharge.

METHODS A retrospective cohort study was conducted within an academic primary care center staffed by family medicine trained physicians that evaluated patients who attended a hospital follow-up visit with pharmacist-enhanced care ($N = 86$) versus usual care ($N = 86$). The primary objective was to describe medication-related problems identified by pharmacists using a modified individualized Medication Assessment and Planning tool for patients receiving pharmacist-enhanced care. Secondary analyses were also conducted to compare 30-day and 60-day hospital readmission and emergency department visit rates in those exposed to pharmacist-enhanced care versus those who were not.

RESULTS At baseline, the mean hospitalizations in the prior year were 1.1 ± 1.7 (pharmacist-enhanced care) and 0.76 ± 1.2 (usual care), indicating a low initial readmission risk. Of patients receiving pharmacist-enhanced care, 97.7% were found to have at least 1 medication-related problem, with an average of 4.36 medication-related problems per patient. The 30-day readmission rate was lower, but not significantly different between groups (8.1% for pharmacist-enhanced care versus 12.8% for usual care; adjusted odds ratio (OR), 0.47; 95% confidence interval (CI), 0.16–1.36).

LIMITATIONS Limitations include the retrospective cohort study design and small sample size. Medication-related problems were identified and collected prospectively during pharmacist visits.

CONCLUSION Medication-related problems are ubiquitous after hospital discharge. Larger prospective studies will be needed to understand the potential value of pharmacist-enhanced care during hospital follow-up visits on readmission rates in low-risk patient populations receiving care within a primary care medical home.

Medication-related problems (MRPs) are broadly defined as events or circumstances involving drug therapy that actually or potentially interfere with desired health outcomes [1]. Care transitions, which include patients moving between the acute and ambulatory care settings, are times of high risk for MRPs. Studies have demonstrated that 15%–60% of patients have at least one MRP while transitioning from hospital to home [2–6]. Adverse events from MRPs also have the potential for profound impact on patient outcomes, including increased rates of hospital readmissions [7].

Identifying and defining the most commonly encountered post-discharge MRPs can better inform development of interventions aimed at reducing and resolving MRPs, as well as reducing readmissions. Other studies have reported MRPs by type, but most studies do not utilize validated categorization tools, incorporate small samples, exclude specific medications and/or classes, or have narrowed patient populations [8–13]. An enhanced understanding of the most common MRPs, medications, and classes involved during care

transitions for a primary care population can help to better target medication-related interventions in this setting.

Given the morbidity and mortality associated with MRPs, the Joint Commission has incorporated medication reconciliation as a National Patient Safety Goal [14]. Pharmacists are well-suited to identify and resolve MRPs [8, 15–20]. Evidence is variable to define which specific interventions may reduce MRPs and reduce readmissions during care transitions. There is also a lack of evidence to define which health care professionals should provide clinical care to reduce MRPs and which patient populations would most benefit from

Electronically published February 5, 2018.

Address correspondence to Emily M. Hawes, UNC Eshelman School of Pharmacy, 115J Beard Hall, CB #7574, Chapel Hill, NC 27599-7574 (emily_hawes@med.unc.edu) or Nicole R. Pinelli, UNC Eshelman School of Pharmacy, Division of Practice Advancement and Clinical Education, 115F Beard Hall, CB #7574, Chapel Hill, NC 27599-7574 (nickipinelli@unc.edu).

N C Med J. 2018;79(1):4–13. ©2018 by the North Carolina Institute of Medicine and The Duke Endowment. All rights reserved. 0029-2559/2018/79101

this intervention [20-22]. The majority of studies evaluating pharmacist involvement have incorporated interventions while the patient is in the acute care setting. However, less evidence is available to evaluate interventions after patients leave the hospital, including face-to-face pharmacist visits [20]. A recent meta-analysis, which incorporates studies evaluating post-discharge methods, determined that pharmacy-led medication reconciliation interventions were an effective strategy to reduce medication discrepancies. These interventions had a greater impact when conducted at either admission or discharge, but were found to be less effective across multiple transitions in care, including in the ambulatory care setting [20]. A systematic review by Ensing and colleagues found that performing medication reconciliation alone is insufficient in reducing post-discharge clinical outcomes (ie, mortality, readmissions, emergency department visits, and adverse drug events [ADEs]), and should be combined with active patient counseling and a clinical medication review [22]. Both analyses highlighted the need for more well-designed studies to determine the patient population and transition points where pharmacist involvement is most beneficial [20, 22].

A pilot study was conducted at the University of North Carolina at Chapel Hill (UNC) Family Medicine Center (FMC) to evaluate the impact of a pharmacist-led pharmacotherapy clinic visit focused on medication reconciliation and patient education on health care utilization. This prospective, randomized, open-label study demonstrated resolution of medication discrepancies and significant reductions in emergency department (ED) visits and readmissions in high-risk patients [18]. The patients had either more than 3 hospitalizations in the past 5 years; 8 or more scheduled medications anticipated at discharge; or a reason for admission of heart failure, chronic obstructive pulmonary disease (COPD), stroke, unstable angina, or non-ST segment myocardial infarction. Furthermore, our institution's internal readmission risk stratification considers patients with 3 or more hospital admissions in the last year, or at least 3 chronic conditions and at least 10 medications, as high-risk; 2 or more hospital admissions in the last year, or at least 2 chronic conditions with no regard to medications, as moderate-risk; and all other patients as low-risk [23]. Studies evaluating the impact of similar face-to-face pharmacist interventions at UNC in moderate to high-risk patients have demonstrated significant reductions in utilization [18, 23].

Given the success demonstrated by pharmacist involvement in the higher-risk populations, and at the request of the clinic's medical providers, our clinic broadly implemented hospital follow-up visits with clinical pharmacists for all recently admitted FMC patients. The study represents the retrospective evaluation of this outpatient-based, multidisciplinary transitions program deployed to all FMC patients discharged from the institution's inpatient service, regardless of readmission risk.

The primary objective of our study was to describe MRPs

identified by clinical pharmacists during multidisciplinary hospital follow-up visits. Our secondary objective was to compare 30-day and 60-day hospital readmission rates in patients seen by pharmacist-enhanced care (PEC) versus usual primary care.

Methods

Study Design

We conducted a retrospective cohort study of patients from the FMC who attended a hospital follow-up visit between January and September 2013. The FMC is the largest primary care unit in the UNC Medical Center (MC). It is the clinical setting for 40 faculty members, 26 resident physicians, and 2 pharmacists, caring for a population of approximately 19,000 patients that have over 61,000 outpatient visits per year. The demographic breakdown of the patient population is approximately 57% white, 29% African American, 4% Hispanic, and 4% Asian. Approximately 18% of patients have Medicaid as primary insurance and another 13% are uninsured. The FMC is a Level 3 Patient-Centered Medical Home certified by the National Committee for Quality Assurance. About 2,200 patients from the FMC are admitted to the hospital annually, with the majority cared for on the Family Medicine Inpatient Service (FMIS); approximately 20% of these patients were readmitted within 30 days in 2012. Based on the institution's internal readmission risk stratification, about 25% of patients discharged from the FMIS are considered low-risk, 40% moderate-risk, and 35% high-risk.

The 2 pharmacists at the FMC are licensed as Clinical Pharmacist Practitioners (CPPs) by the North Carolina Medical Board, which enables collaborative practice through prescribing medications and ordering labs under the supervision of a licensed physician. The CPP positions include clinical and non-clinical responsibilities and are split-funded between the UNC Department of Family Medicine, Access Care regional network of Community Care of North Carolina, and UNC MC. During the study period, the pharmacotherapy clinic focused on management of chronic diseases, such as atrial fibrillation and heart failure, as well as medication reconciliation after discharge within the same clinic template. This clinic had availability for a total of 56 patients to be seen in 30-minute CPP appointments on a weekly basis with highest priority on chronic disease management, resulting in limited space for transitional care appointments.

Patients were scheduled for a multidisciplinary primary care visit following discharge from the institution's FMIS. A hospital follow-up appointment with a pharmacist was scheduled for patients at the time of hospital discharge by a clinic scheduler and was attempted for all FMC patients. The FMC scheduler often worked with the inpatient administrative staff and the patient to determine the appointment date and time. The pharmacist visit was linked to a primary care provider (PCP) visit on the same day in the electronic scheduling system and required aligning appointment openings in

both the pharmacotherapy clinic templates and PCP schedules. Preference was given to the PCP availability. All patients received an automated appointment reminder phone call by UNC MC. For the PEC arm, a reminder phone call about the appointment was made by pharmacy students and pharmacy postgraduate residents one business day before the visit. Patients were reminded to bring medication bottles, pill boxes, and medication-related devices (eg, inhalers) to the appointment. During the 30-minute visit, the pharmacist performed discharge medication reconciliation, identified and intervened on MRPs, and provided patient education. The pharmacist visit was followed by a 20-minute visit with the PCP, with a brief face-to-face huddle in between to discuss identified issues and provide recommendations. Social workers were also available if needed.

Patients were included if they were aged 18 years or older, discharged from the academic institution's FMIS, discharged to a community dwelling, had established primary care with an FMC provider, and attended a hospital follow-up visit within 30 days of discharge. Patients were excluded if they transferred to another medical service other than FMIS; were discharged to a skilled nursing facility, rehabilitation facility, or hospice; or received primary care at a location other than the FMC. Those patients seen by a pharmacist during the hospital follow-up visit were classified as receiving PEC. Those patients seen by the PCP for hospital follow-up but not by pharmacists were considered to have usual care. Usual care subjects were identified using reporting from the electronic medical record (EMR) and selected if they were discharged on the same day (± 3 days) as PEC subjects. The rationale for matching discharge date between usual care and PEC subjects was to help ensure consistency in the inpatient care delivered, including discharge services and medical teams, across arms. Only 1 usual care patient met the study criteria for each of the 76 PEC patients, while 10 PEC subjects had 2 usual care options that were eligible. When faced with deciding between the 2 options, the patient with the discharge date closest to the PEC patient was selected. Patient demographics were not matched.

For the patients receiving PEC, MRPs were categorized by a pharmacist during the hospital follow-up visit using a modified individualized Medication Assessment and Planning (iMAP) tool and then described based on iMAP category, subcategory, American Hospital Formulary Service (AHFS) therapeutic class, and medication [24-26]. The AHFS Classification is a standardized system for coding drugs with similar pharmacologic, therapeutic, or chemical characteristics in a 4-tier hierarchy that is used primarily to organize drug formularies and to facilitate utilization review of drugs by class [26]. Of note, the iMAP classification was verified by 2 pharmacists for accuracy. The tool contains 6 primary domains for classifying MRPs, subcategories to further describe the problem, and accompanying recommendations. A 7th domain, medication list discrepancy, was added for this study.

Continuous Quality Improvement (CQI)—specifically conducting sequential Plan, Do, Study, Act cycles—is an integral part of the FMC framework. At the beginning of PEC deployment, process factors including rates of appointment attendance, percent of patients bringing medication bottles, and patient satisfaction were tracked. For the first 3 months, patients were provided a written satisfaction survey (see Figure 1) at the end of the PEC visit, which they were asked to complete voluntarily and anonymously and then return it to a specific box at the front of the clinic.

The EMR system, WebCIS, was retrospectively reviewed to obtain 30 and 60-day readmission and ED visit rates, demographic data, comorbidities, and scheduled medications. If a patient had an ED visit that led to a subsequent hospitalization, this event was only recorded as a hospitalization. The study was approved by UNC's Institutional Review Board.

Outcomes

The primary objective was to describe MRPs identified by pharmacists using a modified iMAP tool for patients who attended a hospital follow-up visit with PEC. The secondary objective was to compare 30-day and 60-day hospital readmissions, as well as ED visits within 30 days and 60 days post hospital discharge, in those exposed to PEC versus usual care. Other outcomes included describing the most common drug classes and medications associated with MRPs.

Statistical Analysis

Descriptive statistics were used to summarize demographics and MRP classification for the primary objective. Categorical variables of gender, race, ethnicity, insurance status, and visit within 7 days of hospital discharge were compared using Pearson's χ^2 test. A 2-sample t-test was used to compare normally distributed continuous variables, which were reported as means (\pm standard deviation), including age, height, weight, body mass index, number of previous admissions in the past year, number of medications on discharge summary, number of comorbidities, and length of hospital stay. Multivariable logistic regression was used to control for confounders and determine adjusted odds ratios (OR) for secondary outcomes of health care utilization. To help identify potential confounders, all the independent variables were examined for any unequal distribution between the PEC and usual care groups, using means for the continuous variables and percentages for the categorical variables. Bivariable analyses were also performed to examine the unadjusted relationship between each of the independent variables and outcomes (readmission within 30 days and 60 days and ED visit within 30 days and 60 days). In determining the multivariate logistic regression, the 7-category variable for race was treated as nominal and modeled using 2 indicator variables (white and non-white). The 6-category variable for insurance type was treated as

nominal and modeled using 2 indicator variables (insurance and no insurance). After fitting a model that included the pharmacist presence and all potential confounders, change-in-effect was examined to remove any variables from the models that did not meaningfully change the adjusted OR estimate for the pharmacist present, and thus were not confounders of the PEC and readmission relationship. Any factors that changed this fully adjusted OR by greater than 10% when dropped were retained in the final models. An adjusted OR and 95% confidence interval (CI) for PEC versus usual care were calculated from the estimates of the final logistic regression model for each health care utilization outcome. Unadjusted ORs and 95% CIs were also included for reference comparison. Data analysis was performed using STATA 13.0 for Mac (STATA Corporation, College Station, TX, USA). Statistical significance was determined by a *P* value of < .05.

Results

Patient Characteristics

From January to September 2013, 86 patients attended a hospital follow-up with PEC. Baseline demographics are described in Table 1. The demographics were compared for PEC (*N* = 86) versus usual care (*N* = 86) and corresponding *P* values presented. Of note, the only significant differences

between the 2 groups included weight and BMI (for which the PEC group had a higher mean), and hospital length of stay (for which the usual care group had a higher mean). The most common comorbidities among PEC versus usual care were hypertension (74% versus 71%), obesity (49% versus 31%), dyslipidemia (40% versus 37%), depression (36% versus 27%), and diabetes (36% versus 28%). At baseline, the mean hospitalizations in the prior year were 1.1 ± 1.7 (PEC) and 0.76 ± 1.2 (usual care), indicating a low initial readmission risk.

Medication-Related Problems

For the PEC patients, a total of 375 MRPs were identified by the pharmacist during the hospital follow-up visits for the 86 patients. A mean of 4.36 ± 2.65 and range of 0–11 MRPs per patient were found. Almost every patient (97.7%) had at least 1 MRP. Table 2 summarizes the MRPs identified. The most common types of MRPs by iMAP classification were: nonadherence (37.6%); suboptimal dosing, duration, frequency, and administration (19.7%); and suboptimal drug (17.1%). The most common subcategories for nonadherence MRPs were: could not afford (17.9%), patient not aware of medication change (17.9%), and misunderstood directions (17.1%). The most common subcategories for subop-

FIGURE 1.
Patient Satisfaction Survey

Patient Satisfaction Survey

The providers at the UNC Family Medicine Center thank you for being willing to participate in this survey to tell us about your satisfaction with your hospital follow up visit at the clinic. The information you provide will help us as we continually strive to improve care for you and other patients in the future. Please answer the following questions regarding your appointment at the UNC Family Medicine Center today. Again, your participation is greatly appreciated.

Please rate (circle) your level of agreement or disagreement with the following two statements on a scale of 1 – 5, with 5 being strongly agree and 1 being strongly disagree:

1. The hospital follow up visit was helpful/useful.
 1 2 3 4 5
 (strongly disagree) (strongly agree)
 Comments _____

2. At the hospital follow up visit, I learned something new about my medications.
 1 2 3 4 5
 (strongly disagree) (strongly agree)
 Comments _____

Please rate your level of satisfaction in the following areas on a scale of 1 – 5, with 5 being the most satisfied (5= very satisfied) and 1 being the least satisfied (1= very dissatisfied).

3. Ability to receive answers to the medication-related questions you had after hospital discharge
 1 2 3 4 5
 (very dissatisfied) (very satisfied)

4. Ability to get help with any medication-related problems you had after hospital discharge
 1 2 3 4 5
 (very dissatisfied) (very satisfied)

5. Understanding of what medications you should be taking after the hospital follow up clinic visit
 1 2 3 4 5
 (very dissatisfied) (very satisfied)

6. Duration or time length of the appointment
 1 2 3 4 5
 (very dissatisfied) (very satisfied)

7. Overall experience of the hospital follow-up clinic visit at the Family Medicine Center
 1 2 3 4 5
 (very dissatisfied) (very satisfied)
 Comments _____

TABLE 1.
Patient Characteristics by Those with Pharmacist-Enhanced Care (PEC) Versus Usual Care at Follow-Up

Characteristic ^a	PEC Mean \pm SD or % (n = 86)	Usual care Mean \pm SD or % (n = 86)	P value
Age in years	57.4 \pm 16.3	60.3 \pm 14.8	.22
% Male	51.2	45.4	.45
% White ^b	51.2	54.7	.65
African American	45.4	39.5	
Pacific Islander	1.2	0	
White	51.2	54.7	
Other	2.4	5.8	
Ethnicity (% non-Hispanic/Latino)	98.8	97.7	.56
Insurance status (% with insurance, 1–5) ^b	87.2	90.7	.47
None (0)	12.8	9.3	
Medicaid (1)	12.8	5.8	
Medicare (2)	50	52.3	
Private (3)	24.4	20.9	
Charity (4)	0	9.3	
Other (5)	0	2.4	
Height (in)	67.5 \pm 4.6	66.5 \pm 4.9	.18
Weight (kg)	96.7 \pm 30.0	80.6 \pm 28.5	< .01 ^c
Body mass index	32.9 \pm 9.9	28.1 \pm 9.9	< .01 ^c
Number of medications (both scheduled and as needed) on discharge summary	11.5 \pm 7.5	11.2 \pm 6.3	.75
Number of comorbidities	4.3 \pm 2.5	4.1 \pm 2.3	.55
Visit < 7 days of hospital stay	55.8	62.8	.35
Number of previous admissions	1.1 \pm 1.7	0.76 \pm 1.2	.09
Number of days between discharge date and hospital follow-up appointment	9.5 \pm 7.3	8.5 \pm 6.5	.32
Hospital length of stay (days)	2.4 \pm 2.1	3.5 \pm 4.0	.02 ^c

Note. SD, standard deviation.

^aBased on means (\pm SD) for continuous variables and percentages for categorical variables. P values calculated using 2-sample t-tests and Pearson's χ^2 test.

^bRace was consolidated to 2 categories (white and non-white) and insurance status was consolidated to 2 categories (insurance and no insurance).

^cP values less than .05 were considered significant.

^dComorbidities collected included: chronic obstructive pulmonary disease, asthma, coronary artery disease, dyslipidemia, depression, anxiety, heart failure, diabetes, dementia, cognitive impairment, atrial fibrillation, stroke, chronic pain, arthritis, gout, neuropathy, obesity, hypertension, thyroid disease, chronic kidney disease, hepatic disease, and cancer.

timal dosing, duration, frequency, and administration were: administration not ideal or correct (32.9%), dose too low (30.1%), and frequency not correct (19.2%). The most common subcategories for suboptimal drug were: no indication for therapy (31.1%), therapeutic duplication (19.7%), and potential for drug interaction and safer alternative available (14.8% each).

The most frequent medications associated with MRPs were insulin (N = 16), omeprazole (N = 16), and aspirin (N = 12). Central nervous system (CNS), cardiovascular (CV), and gastrointestinal (GI) drugs were the AHFS classifications most frequently associated with MRPs (N = 77, 67, and 45, respectively). Figure 2 displays the 10 most common associated medications and AHFS classes for the identified MRPs. The 10 most common of the 139 different medications identified represent 21.3% of MRPs. The 10 most common of the 19 unique AHFS categories represent 83.5% of MRPs.

Health Care Utilization

The 30-day readmission rate was 8.1% for those with PEC during the hospital follow-up visit and 12.8% for those with usual care (adjusted OR, 0.47; 95% CI, 0.16–1.36; $P = .162$). The 60-day readmission rate was 14.0% with PEC versus 18.6% with usual care (adjusted OR, 0.54; 95% CI, 0.221–.31; $P = .171$). The 30-day ED visit rates were 18.6% in both groups (adjusted OR, 0.76; 95% CI, 0.331–.77; $P = .530$). The 60-day ED visit rates were 22.1% in both groups (adjusted OR, 0.75; 95% CI, 0.34–1.66; $P = .484$). Table 3 presents the comparison of health care utilization using unadjusted and adjusted ORs in those who had PEC versus those with usual care.

Process Characteristics

The no-show rate for PEC scheduled appointments during the first 3 months was 30% (N = 14/46), which is

higher than the FMC overall no-show rate of 9%-11%, but lower than prior rates for pharmacist-only hospital follow-up appointments of 58%. During this time, 69% of patients (N = 22/32) brought medication bottles to the PEC appoint-

ments. Finally, 14 patients completed and returned the volunteer anonymous survey (Figure 1). The mean scores are as follows: 4.4 for question 1 and 6, 4.6 for questions 2 through 5, and 4.8 for question 7.

TABLE 2.
Medication-Related Problems

		N	%
1. Undertreatment	TOTAL	20	5.7
	1.a Additional therapy required	12	60
	1.b Untreated medical condition	8	40
2. Suboptimal dosing, duration, frequency, or administration	TOTAL	73	20.8
	2.a Dose too low	22	30.1
	2.b Dose too high	10	13.7
	2.c Duration too short	1	1.4
	2.d Duration too long	1	1.4
	2.e Administration not ideal or correct	24	32.9
	2.f Frequency not correct	14	19.2
	2.g Other	1	1.4
3. Medication monitoring needed	TOTAL	26	7.4
	3.a Monitoring needed to assess effectiveness/response to therapy	7	26.9
	3.b Monitoring needed to assess/prevent potential adverse drug events	7	26.9
	3.c Monitoring needed for both of the above	10	38.5
	3.d Other	2	7.7
4. Suboptimal drug	TOTAL	61	17.4
	4.a Safer alternative available	9	14.8
	4.b Not effective	3	4.9
	4.c No indication or need for therapy	19	31.1
	4.d Potential for drug interaction	9	14.8
	4.e Therapeutic duplication	12	19.7
	4.f Contraindication to therapy exists	3	4.9
	4.g Generic alternative available	0	0.0
	4.h Preferred formulary alternative	1	1.6
	4.i Less expensive over-the-counter alternative available	0	0.0
	4.j Other	5	8.2
5. Adverse drug event present	TOTAL	7	2.0
	5.a Moderate	7	100.0
	5.b Severe	0	0.0
6. Nonadherence	TOTAL	140	39.9
	6.a Misunderstood directions	24	17.1
	6.b Transportation	3	2.1
	6.c Could not afford	25	17.9
	6.d Felt better	5	3.6
	6.e Regimen complex	7	5.0
	6.f Felt worse	4	2.9
	6.g Fear of adverse events	5	3.6
	6.h Patient not aware of medication changes	25	17.9
	6.i Disbelief in drug effectiveness	6	4.3
	6.j Patient overusing medications	4	2.9
	6.k Memory/cannot remember to take medications	10	7.1
	6.l Other	22	15.7
7. Medication discrepancy	TOTAL	24	6.8
	7.a Patient taking and not on medication list	20	83.3
	7.b Medication on medication list but patient was not taking due to being informed not to (so medication list was not updated)	4	16.7

Discussion

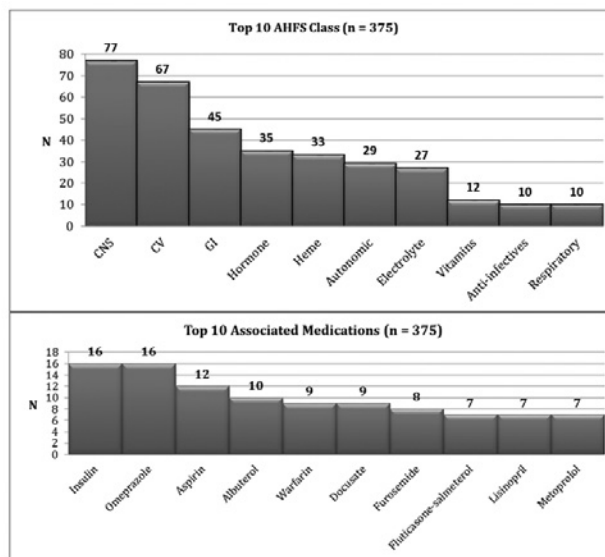
Multiple MRPs were identified during clinical pharmacist visits following hospital discharge, and almost all participants (97.7%) had an MRP. This finding supports the evidence that MRPs are extremely common in transitions of care [9, 20]. Furthermore, MRPs were most frequently categorized as nonadherence, with the primary reasons being patient unawareness of medication changes, difficulty affording a medication, or misunderstood instructions. Nonadherence is often seen in patients post-discharge and these findings highlight the need for not just reconciling medications, but also addressing barriers to medication access and providing medication-related counseling [8, 9, 17, 27].

Our findings on the types of medications associated with MRPs are also consistent with previous data. CNS (including analgesics), CV, and GI drugs are consistently noted as frequently causing MRPs or ADEs after discharge. One study noted corticosteroids, anti-infectives, and anticoagulants among those associated with the highest risk for ADEs. In our study, Hormones and Synthetic Substitutes (corticosteroids) and Blood Formation, Coagulation, and Thrombosis Agents (anticoagulants) were the 4th and 5th most common AHFS categories, respectively, with relatively few MRPs found with anti-infectives [7]. Cardiovascular drugs and analgesics have also been shown to be highly frequent causes of preventable ADEs in the ambulatory care setting [28].

Unfortunately, high-risk medications, which have an increased risk for patient harm, were among the medications associated with MRPs in this study, including insulin (N = 16) and warfarin (N = 9) [29]. Inappropriate use of proton-pump inhibitors has been recently emphasized in the literature [30-32]. This is concerning given the identification of omeprazole-related MRPs in this study (N = 16). Other MRPs included drugs that require regular lab monitoring, especially on initiation (furosemide and lisinopril) or dedicated patient education to promote proper and safe use (albuterol and fluticasone-salmeterol). Previous studies have reported that insulin, antiplatelet drugs, warfarin, diuretics, and beta-blockers are among the most frequent drug causes of ambulatory ADEs that contribute to readmissions [9, 28].

MRPs in this study were identified utilizing a comprehensive, validated tool [24, 25]. Awareness of common MRPs after discharge, as well as the drugs contributing to MRPs, can be used to target interventions to improve the quality of prescribing, monitoring, and patient education during care transitions. Nonadherence due to a patient not being able to afford a medication was the most frequent MRP and led our team to prioritize the cost of medications during the multidisciplinary intervention. Given that lack of awareness of medication changes and misunderstood directions often contributed to nonadherence, our outpatient team

FIGURE 2.
Associated Medications and American Hospital Formulary Service Classes for the Identified Medication-Related Problems



Note. AHFS, American Hospital Formulary Service; CNS, central nervous system; CV, cardiovascular; GI, gastrointestinal.

worked with the inpatient team to make discharge medication-related instructions more succinct and clear. For example, the discharge instructions clearly state in bulleted format what drugs a patient should start, stop, and continue. Furthermore, the hospital follow-up with PEC emphasized updating the medication list, which included discontinuing medications that are no longer needed and ensuring patient-friendly administration instructions to avoid confusion. Due to the frequency of insulin-related MRPs seen in our study, the PEC focused on providing targeted education to all patients on insulin, which is considered a high-risk medication.

The Affordable Care Act has provided a powerful incentive for avoiding rehospitalizations by penalizing hospitals with higher-than-expected readmission rates [33]. Institutions are working to implement evidence-based interventions to reduce 30-day readmission rates. Previous studies show that timely follow-up to primary care and a multidisciplinary approach are impactful interventions to reduce readmissions [33-36]. This study demonstrated non-statistically significant reductions in 30-day and 60-day readmissions for patients seen in a multidisciplinary visit, which included a pharmacist and physician versus physician-only hospital follow-up visit in the primary care setting. However, the 95% CIs are wide and do not exclude a clinically important effect. Most patients were seen within 7 days of discharge. The pharmacist visit focused not only on medication reconciliation, but also on patient education and pharmacotherapy optimization. This aligns with previous findings that medication reconciliation—creating the most accurate and

TABLE 3.
Unadjusted and Adjusted Odds Ratios for Hospital Readmission or ED Visit by Those with Pharmacist-Enhanced Care (PEC) Versus Usual Care at Hospital Follow-Up Visit

Outcome	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
30-day hospital readmission	0.60 (0.22-1.64)	0.47 (0.16-1.36) ^a
60-day hospital readmission	0.71 (0.31-1.61)	0.54 (0.22-1.31) ^b
30-day ED visit	1.00 (0.46-2.16)	0.76 (0.33-1.77) ^c
60-day ED visit	1.00 (0.49-2.06)	0.75 (0.34-1.66) ^d

Note. CI, confidence interval; ED, emergency department; OR, odds ratio.

^aAdjusted for number of previous admissions.

^bAdjusted for number of previous admissions and follow-up visit within 7 days.

^cAdjusted for number of previous admissions, follow-up visit within 7 days, days between hospital discharge and follow-up visit, and hospital length of stay.

^dAdjusted for number of medications at hospital discharge, number of comorbidities, number of previous admissions, follow-up visit within 7 days, days between hospital discharge and follow-up visit, and hospital length of stay.

complete list of medication information—should not be performed alone, but combined with counseling and a clinical medication review [18, 22, 23, 35, 36].

Only a few studies have evaluated face-to-face pharmacist visits incorporated in a multidisciplinary primary care setting. Furthermore, most of these studies have utilized pharmacy services for specific high-risk populations versus all discharged patients [19, 20, 22, 23, 35, 37]. This study adds to the existing but limited body of literature emphasizing a reduction in readmissions, albeit non-significant, following face-to-face pharmacist hospital follow-up visits with a multidisciplinary team in a patient-centered medical home. The lack of significance may be due to the small population size and including a population with relatively “low” readmission risk at baseline. The mean numbers of hospitalizations in the prior year were 1.1 ± 1.7 (PEC) and 0.76 ± 1.2 (usual care). The patients were offered the hospital follow-up visit including PEC regardless of readmission risk; therefore, patient demographics (eg, past number of hospitalizations, medications, or comorbidities) were not considered. Another potential reason for the low readmission rate observed is that only patients who attended a hospital follow-up appointment within 30 days were included in the study, and research indicates that patients are less likely to be readmitted if they attend a primary care follow-up appointment after discharge [34]. Our institution’s internal readmission risk stratification considers patients with 2 past hospitalizations as moderate-risk and those with 3 or more as high-risk [23, 35]. In 2013, moderate and high-risk patients accounted for approximately 84% of all UNC rehospitalizations (40% for moderate-risk and 44% for high-risk). Studies evaluating the impact of similar face-to-face pharmacist interventions at UNC in moderate to high-risk patients have demonstrated significant and pronounced reductions in utilization [18, 23, 35].

Most transitions programs aim to reduce indirect costs as health systems avoid reimbursement penalties for higher-than-expected readmission rates. This study did not address

cost-effectiveness. However, when faced with decisions about allocating resource-intensive pharmacist time in the medical home, it may be prudent to develop transitions programs that prioritize higher risk populations. The non-significant reduction in readmission rates seen in this “low-risk” study population after pharmacist visits suggests that medical home transitions programs may see less financial and clinical benefit from broadly implementing these services to the general population. Significant time and effort was required to schedule a linked appointment that accounted for the PCP and CPP schedules and patient availability. This finding led the administration to simplify the scheduling process and create a FMC transitions clinic where a CPP has blocked time to care for hospital follow-up patients in conjunction with a medical provider and social worker.

Limitations

The current study had limitations worth discussing. Most notably, this study was retrospective because clinic administration decided to implement this multidisciplinary care to all discharged FMC patients; therefore, comparison between the PEC group and a prospective control group was not possible. However, MRPs were identified and collected prospectively during clinical pharmacist visits. Because MRPs were not commonly documented and/or assessed by PCPs as part of their comprehensive visits, MRPs could only be evaluated for the PEC group. The study could have also been improved by evaluating the severity of the identified MRPs [20, 38, 39]. Given that comparison of readmissions and ED visit rates between the groups of PEC and usual care were secondary analyses, another limitation of the study is that it may not have been adequately powered to detect a statistically significant difference in health care utilization. Furthermore, differences in baseline demographics across study arms existed, although the analysis compared models of adjusting for all variables and reported adjusted ORs to account for imbalances. Although all patients were offered the PEC arm at FMIS discharge, patients were not obligated

to participate. This could have led to selecting a PEC group that was more motivated or interested in medication management than the usual care arm. Both the PEC and usual care arms required attendance of a follow-up appointment within 30 days of discharge, which could explain the lower readmission rates across both arms. The small sample size may be due to the significant challenge in aligning the pharmacist and PCP clinic template availability. These process-related findings were instrumental in transforming the multidisciplinary transitional care provided at the FMC, where moderate to high-risk patients are now targeted and pharmacist availability is prioritized.

As we design systems of care that improve quality while decreasing total cost of care, we need to build on successful interventions that identify and ameliorate MRPs. Patients at high risk, including those experiencing transitions of care, are more likely to benefit from clinical pharmacist interventions. Larger prospective studies are needed to determine the most cost-effective strategies for providing clinically-effective care to patients at risk, including when (ie, before, during, or after discharge), where (eg, in the clinic, via telemedicine, or even in patients' homes), how (eg, multidisciplinary clinic or pharmacotherapy clinic), and to whom (ie, low, moderate, or high-risk patients) clinical pharmacists can intervene.

Conclusion

Medication-related problems are very common after discharge. A better understanding of transitions-related MRPs, specifically the medications and classes involved, allows improved medication-management interventions, including more targeted patient education. This study indicates larger prospective studies are needed to evaluate the impact of PEC during hospital follow-up visits in a low-risk patient population receiving care within a primary care medical home. NCMJ

Emily M. Hawes, PharmD, BCPS adjunct associate professor, Department of Family Medicine, UNC School of Medicine; Division of Practice Advancement and Clinical Education, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Nicole R. Pinelli, PharmD, MS, CDE clinical assistant professor, Division of Practice Advancement and Clinical Education, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill North Carolina.

Kimberly A. Sanders, PharmD, BCPS clinical assistant professor, Division of Practice Advancement and Clinical Education, UNC Eshelman School of Pharmacy; Department of Dental Ecology, UNC School of Dentistry, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Andrew M. Lipshutz, PharmD, BCPS patient care pharmacist, Department of Pharmacy, Mount Carmel West Hospital, Columbus, Ohio.

Gretchen Tong, PharmD clinical pharmacist practitioner, clinical instructor, Department of Family Medicine, UNC School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Lauren S. Sievers, PharmD, BCPS ambulatory care clinical pharmacist, Baptist Medical Center South, Montgomery, Alabama.

Sarah Chao PharmD candidate, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Mark Gwynne, DO senior medical director, UNC Health Alliance; associate professor, Department of Family Medicine, UNC School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Acknowledgments

We thank Dr. Mary Roth McClurg and Dr. Ginny Crisp for the use of and training on the iMAP tool. We also thank Andrew Encarnacion for his time and dedication in the demographic data collection process for cases and controls.

Potential conflicts of interest. All authors have no relevant conflicts of interest.

References

1. Pharmaceutical Care Network Europe Foundation. Classification for Drug Related Problems. Pharmaceutical Care Network Europe Foundation; 2010. http://www.pcne.org/upload/files/11_PCNE_classification_V6-2.pdf. Accessed October 13, 2017.
2. Boockvar KS, Carlson Lacorte H, Giambanco V, Fridman B, Siu A. Medication reconciliation for reducing drug-discrepancy adverse events. *Am J Geriatr Pharmacother*. 2006;4(3):236-243.
3. Walker PC, Bernstein SJ, Jones JN, et al. Impact of a pharmacist-facilitated hospital discharge program: a quasi-experimental study. *Arch Intern Med*. 2009;169(21):2003-2010.
4. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. Adverse drug events occurring following hospital discharge. *J Gen Intern Med*. 2005;20(4):317-323.
5. Climente-Martí M, García-Mañón ER, Artero-Mora A, Jiménez-Torres NV. Potential risk of medication discrepancies and reconciliation errors at admission and discharge from an inpatient medical service. *Ann Pharmacother*. 2010;44(11):1747-1754.
6. Cornish PL, Knowles SR, Marchesano R, et al. Unintended medication discrepancies at the time of hospital admission. *Arch Intern Med*. 2005;165(4):424-429.
7. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med*. 2003;138(3):161-167.
8. Conklin JR, Togami JC, Burnett A, Dodd MA, Ray GM. Care transitions service: a pharmacy-driven program for medication reconciliation through the continuum of care. *Am J Health Syst Pharm*. 2014;71(10):802-810.
9. Armor BL, Wight AJ, Carter SM. Evaluation of adverse drug events and medications discrepancies in transitions of care between hospital discharge and primary care follow-up. *J Pharm Pract*. 2016;29(2):132-137.
10. Zemaitis CT, Morris G, Cabie M, Abdelghany O, Lee L. Reducing readmission at an academic medical center: results of a pharmacy-facilitated discharge counseling and medication reconciliation program. *Hosp Pharm*. 2016;51(6):468-473.
11. Rafferty A, Denslow S, Michalets EL. Pharmacist-provided medication management in interdisciplinary transitions in a community hospital (PMIT). *Ann Pharmacother*. 2016;50(8):649-655.
12. Almasneh E, Moles R, Chen TF. The medication reconciliation process and classification of discrepancies: a systematic review. *Br J Clin Pharmacol*. 2016;82(3):645-658.
13. Sebaaly J, Parsons LB, Pilch NA, Bullington W, Hayes GL, Easterling H. Clinical and financial impact of pharmacist involvement in discharge medication reconciliation at an academic medical center: a prospective pilot study. *Hosp Pharm*. 2015;50(6):505-513.
14. The Joint Commission. National Patient Safety Goals Effective January 1, 2015. The Joint Commission; 2015. http://www.jointcommission.org/assets/1/6/2015_NPSG_HAP.pdf. Accessed October 13, 2017.
15. Koehler BE, Richter KM, Youngblood L, et al. Reduction of 30-day postdischarge hospital readmission or emergency department (ED) visit rates in high-risk elderly medical patients through delivery of a targeted care bundle. *J Hosp Med*. 2009;4(4):211-218.
16. Varkey P, Cunningham J, O'Meara J, Bonacci R, Desai N, Sheeler R. Multidisciplinary approach to inpatient medication reconciliation in an academic setting. *Am J Health Syst Pharm*. 2007;64(8):850-854.
17. Garcia-Caballeros M, Ramos-Diaz F, Jimenez-Moleon JJ, Bueno-Cavanillas A. Drug-related problems in older people after hos-

- pital discharge and interventions to reduce them. *Age Ageing*. 2010;39(4):430-438.
18. Hawes EM, Maxwell WD, White SF, Mangun J, Lin FC. Impact of an outpatient pharmacist intervention on medication discrepancies and health care resource utilization in posthospitalization care transitions. *J Prim Care Community Health*. 2014;5(1):14-18.
 19. Phatak A, Prusi R, Ward B, et al. Impact of pharmacist involvement in the transitional care of high-risk patients through medication reconciliation, medication education, and postdischarge call-backs (IPITCH Study). *J Hosp Med*. 2016;11(1):39-44.
 20. Mekonnen AB, McLachlan AJ, Brien JA. Pharmacy led medication reconciliation programmes at hospital transitions: a systematic review and meta-analysis. *J Clin Pharm Ther*. 2016;41(2):128-144.
 21. Hansen LO, Young RS, Hinami K, Leung A, Williams MV. Interventions to reduce 30-day rehospitalization: a systematic review. *Ann Intern Med*. 2011;155(8):520-528.
 22. Ensing HT, Stuijt CC, van den Bemt BJ, et al. Identifying the optimal role for pharmacists in care transitions: a systematic review. *J Manag Care Spec Pharm*. 2015;21(8):614-636.
 23. Cavanaugh JJ, Jones CD, Embree G, et al. Implementation science workshop: primary care-based multidisciplinary readmission prevention program. *J Gen Intern Med*. 2014;29(5):798-804.
 24. Crisp GD, Burkhart JJ, Esserman DA, Weinberger M, Roth MT. Development and testing of a tool for assessing and resolving medication-related problems in older adults in an ambulatory care setting: the individualized medication assessment and planning (iMAP) tool. *Am J Geriatr Pharmacother*. 2011;9(6):451-460.
 25. Roth MT, Ivey JL, Esserman DA, Crisp G, Kurz J, Weinberger M. Individualized medication assessment and planning: optimizing medication use in older adults in the primary care setting. *Pharmacotherapy*. 2013;33(8):787-797.
 26. American Society of Health-System Pharmacists. AHFS pharmacologic-therapeutic classification. AHFS website. <http://www.ahfsdruginformation.com/ahfs-pharmacologic-therapeutic-classification/>. Accessed November 13, 2017.
 27. Coletti DJ, Stephanou H, Mazzola N, Conigliaro J, Gottridge J, Kane JM. Patterns and predictors of medication discrepancies in primary care. *J Eval Clin Pract*. 2015;21(5):831-839.
 28. Thomsen LA, Winterstein AG, Søndergaard B, Haugbølle LS, Melander A. Systematic review of the incidence and characteristics of preventable adverse drug events in ambulatory care. *Ann Pharmacother*. 2007;41(9):1411-1426.
 29. Institute for Safe Medication Practices. ISMP list of high-alert medications in community/ambulatory healthcare. ISMP website. <https://www.ismp.org/communityRx/tools/ambulatoryhighalert.asp>. Published January 30, 2011. Accessed November 3, 2017.
 30. Schepisi R, Fusco S, Sganga F, et al. Inappropriate use of proton pump inhibitors in elderly patients discharged from acute care hospitals. *J Nutr Health Aging*. 2016;20(6):665-670.
 31. Serbin MA, Guzauskas GF, Veenstra DL. Clopidogrel-proton pump inhibitor drug-drug interaction and risk of adverse clinical outcomes among PCI-treated ACS patients: a meta-analysis. *J Manag Care Spec Pharm*. 2016;22(8):939-947.
 32. Schoenfeld AJ, Grady D. Adverse effects associated with proton pump inhibitors. *JAMA Intern Med*. 2016;176(2):172-174.
 33. Centers for Medicare & Medicaid Services. Readmissions Reduction Program (HRRP). CMS website. <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html>. Accessed October 13, 2017.
 34. Coleman EA, Smith JD, Raha D, Min SJ. Posthospital medication discrepancies: prevalence and contributing factors. *Arch Intern Med*. 2005;165(16):1842-1847.
 35. Cavanaugh JJ, Lindsey KN, Shilliday BB, Ratner SP. Pharmacist-coordinated multidisciplinary hospital follow-up visits improve patient outcomes. *J Manag Care Spec Pharm*. 2015;21(3):256-260.
 36. Rochester-Eyegukan CD, Pincus KJ, Patel RS, Reitz SJ. The current landscape of transitions of care practice models: a scoping review. *Pharmacotherapy*. 2016;36(1):117-133.
 37. McNeely EB. Treatment considerations and the role of the clinical pharmacist throughout transitions of care for patients with acute heart failure. *J Pharm Pract*. 2017;30(4):441-450.
 38. Hartwig SC, Denger SD, Schneider PJ. Severity-indexed, incident report-based medication error-reporting program. *Am J Hosp Pharm*. 1991;48(12):2611-2616.
 39. US Department of Veterans Affairs. NCPS Patient Safety Improvement Handbook. US Department of Veterans Affairs website. <https://www.patientsafety.va.gov/professionals/publications/handbook.asp>. Published March 4, 2011. Accessed November 3, 2017.