ORIGINAL ARTICLE

Patterns of Medication Adherence and Health Care Utilization Among Patients With Chronic Disease Who Were Enrolled in a Pharmacy Assistance Program

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BACKGROUND Poor medication adherence due to high drug costs is a barrier to optimal health outcomes among low-income uninsured patients with chronic conditions. Charitable pharmacy assistance programs provide medications to such patients, but little is known about the utilization patterns of program participants.

METHODS We used a retrospective cohort design to investigate 6-month outcomes for participants in the University of North Carolina (UNC) Health Care Pharmacy Assistance Program (PAP) who received medications indicated for hypertension, diabetes, and/or hyperlipidemia from 2009 through 2011. Logistic regression was used to analyze predictors of medication adherence and to evaluate the association between adherence and use of emergency and inpatient care.

RESULTS The 3 study cohorts included 866 patients receiving antihypertensive agents, 265 patients receiving oral glucose-lowering agents, and 455 patients receiving statins. When assessed 6 months after program enrollment, 52%, 45%, and 38% of patients in these 3 groups, respectively, were at least 80% adherent to treatment. Adherent patients in all cohorts had lower odds of requiring inpatient or emergency department care, but the decrease was only statistically significant among those taking antihypertensive agents (odds ratio for hospitalization = 0.58; 95% confidence interval, 0.39–0.87).

LIMITATIONS Selection bias and inability to capture utilization data from sources other than UNC Health Care may have biased results.

CONCLUSION Approximately 50% of PAP participants were adherent to chronic disease medications. Adherence to such therapies among patients who are receiving financial assistance with medications may reduce their need for costly health care services. Future research should assess the long-term ability of pharmacy assistance programs to promote medication adherence and should examine alternative strategies for improving adherence and health outcomes among low-income uninsured patients.

Medication nonadherence is a significant barrier to achieving positive health outcomes for patients with chronic health conditions [1]. Comprehensive meta-analyses report that across all chronic disease states, only 65%–75% of patients adhere to prescribed therapies, on average [2, 3]. Further, among patients with certain common chronic diseases, adherence rates have been shown to be even lower. For example, only 40%–50% of patients with hyperlipidemia adhere to statin therapy beyond 12 months [4, 5]. Poor adherence can result in more rapid disease progression, adverse health outcomes, and increased use of costly health care services. Specifically, patients who are nonadherent to medications for hyperlipidemia [6, 7], type 2 diabetes [8-10], and hypertension [11-14] experience significantly higher rates of emergency department (ED) use, hospitalization, serious cardiovascular events, and death [15].

The cost of medications is a primary contributor to nonadherence [16-19]. In a survey of chronically ill older adults in the United States, nearly half of respondents aged 40–64 years who were employed reported that they had not filled prescriptions or had inappropriately altered their dosing regimen because of the cost of the drug [20]. Not surprisingly, this problem is more pronounced in patients who have limited or no prescription drug coverage, low incomes, and/or multiple comorbidities [21, 22]. Among socioeconomically and medically vulnerable patients, as the cost burden of prescription drugs increases, suboptimal adherence becomes more likely, premature discontinuation of therapy increases, overall health care costs rise, and spending on essential nonmedical needs decreases [23, 24].

Low-income uninsured patients who cannot afford prescription medications may be able to get help from pharmacy assistance programs that provide medications for free or at reduced cost. Such programs vary in their availability, patient eligibility criteria, generosity, and services offered. The Patient Protection and Affordable Care Act of 2010 (ACA) gives states the option to provide coverage to many uninsured citizens through an expansion of the state's

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Medicaid program. As of June 10, 2014, however, 21 states, including North Carolina, had declared that they did not intend to expand their Medicaid programs [25]. In these states, the need for pharmacy assistance programs will continue and may grow; however, the resources of charitable organizations will be stretched by rising health care costs and the number of uninsured patients.

Little is known about the ability of pharmacy assistance programs to serve as a primary source of prescription medications for uninsured low-income patients, nor do we know the effect of these programs on health outcomes. We therefore investigated the medication and health care utilization of patients with chronic health conditions who received prescription assistance through the University of North Carolina (UNC) Health Care Pharmacy Assistance Program (PAP). Specifically, we examined patterns of adherence to medications used to treat diabetes, hyperlipidemia, and hypertension among individuals participating in PAP, as well as their use of inpatient, outpatient, and ED services.

Methods

Study Design

We conducted a retrospective cohort study to examine 6-month outcomes among PAP participants who received oral medications for the long-term management of diabetes, hypertension, and/or hyperlipidemia. These disease states were chosen because of their high prevalence, economic burden on the US health care system, and potential for adverse health consequences stemming from poor medication adherence. Three study cohorts were created; patients were included in one of these cohorts if they received a prescription fill for an oral medication indicated for diabetes, hyperlipidemia, or hypertension following enrollment in PAP. Subjects using medications for more than 1 of these diseases were included in multiple cohorts, and the 6-month observation period varied across cohorts depending on the date of the cohort-specific index prescription fill. The index date was defined as the date of the first prescription for a qualifying medication filled after a patient became newly eligible for PAP services from 2009 through 2011. This study used a prevalent-user design, which allowed inclusion of subjects who were using study medications prior to the observation period.

Patients

Patients were included if they met the following 3 criteria: They enrolled in the UNC Health Care PAP between January 1, 2009, and December 31, 2011; they had at least 1 prescription claim for an oral medication indicated for hyperlipidemia (statins), diabetes (sulfonylureas, thiazolidinediones, or metformin), and/or hypertension (angiotensin-converting enzyme [ACE] inhibitors, angiotensin II receptor blockers, calcium channel blockers, or diuretics); and they had at least 6 months of continuous enrollment in PAP between their index fill date and December 31, 2011. We created the study cohorts based on the presumed primary indication for the medication. Although we were unable to verify a diagnosis due to the lack of health care data prior to PAP enrollment, we assumed that patients receiving 1 of these medications would be expected to adhere to a long-term dosing regimen.

PAP coverage was available to patients who were North Carolina residents, had an annual household income at or below 200% of the federal poverty guidelines, had no health insurance, and were ineligible for any other federal or state health insurance programs. Roughly 80% of PAP participants reported that they had no income when they enrolled in the program. PAP enrollees received a renewable 12-month prescription benefit that gave them access to 30-day prescription fills from a comprehensive formulary at the UNC Health Care outpatient pharmacy. The program's $4 copayments were waived for patients who were unable to pay this amount, and PAP enrollees were not required to pay monthly premiums or deductibles.

Data

Prescription claims data were obtained from the pharmacy benefits management company responsible for overseeing PAP during the study period; these data were then linked to data from the Carolina Data Warehouse for Health, which contains demographic information and detailed administrative claims data for all inpatient, ED, and outpatient services provided throughout the UNC Health Care system. Finally, patient-level program enrollment information was abstracted from PAP administrative records. All linked data sets were deidentified to ensure confidentiality before data were used for research purposes. This study was approved by the Biomedical Institutional Review Board of the University of North Carolina at Chapel Hill.

Prescription Utilization Measures

Medication adherence was calculated using PAP prescription claims data for the 6-month observation period, beginning on the date of the index prescription fill; specifically, proportion of days covered (PDC), a measure of medication adherence [4], was calculated by taking the number of days in the observation period for which the patient had available drug supply and dividing that by the total number of days in the observation period. PDC represents overall adherence to medications for treating the disease state, as opposed to adherence to a specific drug. For example, for subjects who received multiple antihypertensive products, adherence was calculated based on the availability of any antihypertensive drug during the observation period.

In addition to this continuous measure of adherence, we created a dichotomous measure of adherence. Based on other studies [4, 26, 27], we set the threshold for adherence at 80%—that is, patients were deemed to be adherent if they had a PDC equal to or greater than 0.8. Also, we calculated the total number of unique drug products for which

a prescription was filled during the 6-month observation period, regardless of whether they were used to treat the disease that defined the cohort; this number was used as a proxy for therapeutic complexity and disease burden. Binary variables were created to indicate the inclusion of patients in each of the 3 cohorts.

Measures of Health Care Utilization

Binary variables were used to indicate whether a patient visited the ED or was admitted to the hospital during the 6-month period following the index date. ED visits resulting in an inpatient hospitalization were classified solely as inpatient care, not as ED care. The descriptive analyses included the number of ED visits, inpatient admissions, and outpatient visits during the 6-month observation period among those with at least 1 such visit or admission. Average length of stay (in days) was also measured for inpatient hospitalizations.

Demographic Measures

Patient-level demographic measures included age, sex, self-reported race (white, black, or other); preferred language (English, Spanish, or other); local residence (either Orange County [where UNC Health Care is located], any of the 5 bordering counties [Chatham, Alamance, Caswell, Person, or Durham], or nearby Wake County); and economic status of the patient's county of residence (determined using the North Carolina Department of Commerce's county tier designations for 2013 [28], in which Tier 1 consists of the 40 most economically distressed counties, Tier 2 consists of the 40 next-most-distressed counties, and Tier 3 consists of the 20 least distressed counties). Demographic variables were assessed at baseline during the PAP enrollment process.

Statistical Analysis

We calculated patient-level demographic characteristics, prescription use, and health care utilization for each cohort. Within each cohort, logistic regression was used to assess bivariate differences in adherence (PDC <0.8 versus PDC ≥0.8) for patient-level covariates that were identified a priori: age, sex, race, preferred language, number of unique drugs for which prescriptions were filled, and concomitant enrollment in other study cohorts. Bivariate logistic regression was performed to examine the distribution of covariate characteristics across values of the binary adherence dependent variable for each cohort. Multivariable logistic regression was used to examine the impact of the predefined covariates on medication adherence (primary outcome). Multivariable logistic regression was also used to investigate the association of medication adherence with ED use and with inpatient admission during the observation period for each of the 3 cohorts, while controlling for the previously specified covariates. Odds ratios (OR) and 95% confidence intervals (CI) for logistic regression models were reported. Statistical analyses were performed using Stata version 11.2 software [29].

Results

Of 7,180 individuals newly enrolled in the UNC Health Care PAP from 2009 through 2011, a total of 2,695 patients filled a prescription for an antihypertensive agent, 873 filled a prescription for an oral glucose-lowering agent, and 1,349 filled a prescription for a statin. After applying the eligibility criteria, our final study cohorts consisted of 866, 265, and 455 PAP participants using antihypertensive agents, oral glucose-lowering agents, and statins, respectively.

Table 1 describes the demographic characteristics, prescription use, and health care utilization of each cohort. Substantial overlap exists across the 3 study cohorts: 64% of the patients receiving oral glucose-lowering agents and 70% of the statin users also concomitantly received antihypertensive agents, and more than 50% of the patients receiving oral glucose-lowering agents were also taking statins.

Patient-level demographic characteristics were fairly evenly distributed across the 3 cohorts. The mean age of the patients was about 50 years, and roughly half of patients were female, self-identified as white, and lived in an economically robust (Tier 3) county. The preferred language of most patients was English. Patients receiving oral glucose-lowering agents were slightly more likely to be female, to be racially diverse, to designate Spanish as their preferred language, and to live in a local county compared with patients in the other 2 cohorts.

The 3 study cohorts were similar in their prescription use and their utilization of health care. On average, study patients filled prescriptions for roughly 9 unique medications during the 6-month observation period. In addition, nearly 90% of patients in each cohort had at least 1 outpatient visit during the observation period, fewer than 20% were hospitalized, and about 20% visited the ED at least once.

During the 6-month observation period, mean adherence rates (measured in terms of continuous PDC) were 0.61, 0.67, and 0.70 for new PAP participants using statins, oral glucose-lowering agents, and antihypertensive agents, respectively (Table 2). Observed adherence rates were slightly lower for the individual classes of drugs included within the categories of oral glucose-lowering agents and antihypertensive agents (eg, metformin or ACE inhibitors, respectively). When adherence was defined as PDC equal to or greater than 0.8, this benchmark was met by 38%, 45%, and 52% of the patients taking statins, glucose-lowering agents, and antihypertensive agents, respectively.

Bivariate analyses revealed that, compared with nonadherent patients, adherent patients were significantly older, more likely to be white (if they were taking oral glucose-lowering agents or statins), more likely to be concomitantly using 2 classes of medications (eg, antihypertensive agents and statins), and filled prescriptions for more unique medi-

TABLE 1.
Demographic Characteristics and Health Care Utilization of Newly Enrolled[a] Participants in the UNC Health Care Pharmacy Assistance Program Receiving Oral Pharmacotherapy for Common Chronic Diseases

Characteristic/variable	Users of antihypertensive agents (N = 866)	Users of oral glucose-lowering agents (N = 265)	Users of statins (N = 455)
Age (in years), Mean±SD	49±11	49±11	51±9
Female sex, No. (%)	435 (50%)	144 (54%)	211 (46%)
Race, No. (%)			
White	412 (48%)	115 (43%)	248 (55%)
Black	324 (37%)	84 (32%)	142 (31%)
Other	130 (15%)	66 (25%)	65 (14%)
Preferred language, No. (%)			
English	736 (85%)	201 (76%)	394 (87%)
Spanish	74 (9%)	49 (18%)	39 (9%)
Other	56 (6%)	15 (6%)	22 (5%)
Local residence[b], No. (%)	568 (66%)	189 (71%)	315 (69%)
Economic status of county of residence[c], No. (%)			
Tier 1	62 (7%)	11 (4%)	31 (7%)
Tier 2	366 (42%)	111 (42%)	199 (44%)
Tier 3	438 (51%)	143 (54%)	225 (49%)
No. of unique drugs for which a prescription was filled, Mean±SD	8.3±4.5	9.2±4.8	9.3±4.7
Health care utilization			
Outpatient care			
Patients making any visit, No. (%)	755 (87%)	231 (87%)	402 (88%)
No. of visits by those making at least 1 visit, Mean±SD	5.34±4.90	4.74±5.18	5.07±4.45
Inpatient care			
Patients with any hospital admission, No. (%)	168 (19%)	42 (16%)	72 (16%)
No. of admissions among those with at least 1 admission, Mean±SD	1.64±1.34	1.57±1.21	1.65±1.13
Length of stay (in days), Mean±SD	4.44±6.59	3.47±3.00	5.53±9.08
Emergency department care			
Recipients who visited the emergency department, No. (%)	179 (21%)	50 (19%)	90 (20%)
No. of visits among those making at least 1 visit to the emergency department, Mean±SD	1.95±2.50	1.96±1.85	1.57±1.43

Note. UNC, University of North Carolina; SD, standard deviation.
[a]Enrollment in multiple study cohorts was allowed. A total of 325 patients were taking both antihypertensive agents and statins; 170 patients were taking both antihypertensive agents and oral glucose-lowering agents; 137 patients were taking both oral glucose-lowering agents and statins; and 112 patients were enrolled in all 3 study cohorts.
[b]Local residence was defined as living in 1 of these 7 counties: Orange, Chatham, Alamance, Caswell, Person, Durham, or Wake.
[c]North Carolina Department of Commerce county tier designations for 2013 [28] were used to determine the economic status of the patient's county of residence. Tier 1 counties are the state's 40 most economically distressed counties; Tier 2 counties are the 40 next-most-distressed counties; and Tier 1 counties are the 20 least economically distressed counties.

cations (Table 3). In addition, patients who were receiving antihypertensive agents and who were local residents were more likely to be adherent.

When all covariates were included, multivariable logistic regression results showed that these trends did not change; however, not all associations remained statistically significant (Table 4). Older age was a statistically significant predictor of adherence to antihypertensive agents (OR = 1.03; 95% CI, 1.01–1.04) and adherence to statins (OR = 1.03; 95% CI, 1.00–1.05). Similarly, the number of unique medications for which prescriptions were filled also had a statistically significant positive association with adherence to antihypertensive agents and with adherence to statins. White race was associated with 83% greater odds of adherence to oral glucose-lowering agents (OR = 1.83; 95% CI, 1.05–3.21) and 82% greater odds of adherence to statins (OR = 1.82; 95% CI, 1.19–2.79). For patients in the antihypertensive cohort, concomitant use of statins significantly increased the odds of adherence to antihypertensive agents. Patient sex, language preference, and local residence were not associated with adherence to medications for any of the 3 cohorts.

Our analysis suggested a negative association between adherence and ED use in each study cohort (Table 5), but none of the ORs were statistically significant. Filling prescrip-

TABLE 2.
Six-Month Adherence Among Newly Enrolled Participants in the UNC Health Care Pharmacy Assistance Program to Medications in Certain Drug Classes, Across Cohorts of Users With Common Chronic Diseases

Drug class	No. of patients	Adherence, in PDC Mean±SD	Nonadherent patients (PDC<0.5) No. (%)	Low-adherence patients (PDC = 0.5–0.79) No. (%)	Adherent patients (PDC≥0.8) No. (%)
Statins	455	0.61±0.30	147 (32%)	134 (29%)	172 (38%)
All oral glucose-lowering agents[a]	265	0.67±0.31	73 (28%)	70 (26%)	120 (45%)
Metformin	230	0.62±0.28	63 (27%)	85 (37%)	80 (35%)
Sulfonylureas	114	0.63±0.30	33 (29%)	34 (30%)	47 (41%)
Thiazolidinediones	31	0.64±0.29	8 (26%)	9 (29%)	14 (45%)
All oral antihypertensive agents[a]	866	0.70±0.31	225 (26%)	190 (22%)	449 (52%)
ACE inhibitors/ARBs	534	0.61±0.29	168 (31%)	164 (31%)	200 (37%)
Beta blockers	495	0.59±0.31	159 (38%)	115 (28%)	142 (34%)
Calcium channel blockers	324	0.61±0.30	96 (33%)	84 (29%)	110 (38%)
Diuretics	502	0.61±0.31	187 (37%)	111 (22%)	203 (40%)

Note: ACE, angiotensin-converting enzyme; ARBs, angiotensin II receptor blockers; PDC, proportion of days covered; SD, standard deviation; UNC, University of North Carolina.
[a]Adherence measures for "all oral glucose-lowering agents" and "all oral antihypertensive agents" reflect overall, aggregate adherence, calculated by totaling the number of days in which any medication indicated for the disease was available, divided by the number of days in the observation period.

tions for a greater number of unique medications was associated with greater likelihood of an ED visit among patients taking antihypertensive agents (OR = 1.12; 95% CI, 1.07–1.17), oral glucose-lowering agents (OR = 1.16; 95% CI, 1.07–1.25), or statins (OR = 1.09; 95% CI, 1.03–1.15). Patients taking antihypertensive agents whose preferred language was English were also more likely to receive ED care (OR = 2.63; 95% CI, 1.34–5.13). Local residence had a statistically significant positive association with ED use in all 3 cohorts. Although the point estimates suggested that concomitant use of medications from 2 or more study cohorts (eg, antihypertensive agents and statins) was associated with decreased odds of an ED visit, none of the ORs reached statistical significance.

The odds of inpatient admission were lower for adherent patients in each study cohort compared with nonadherent patients, but this finding was statistically significant only for patients receiving antihypertensive agents (OR = 0.42; 95% CI, 0.39–0.87; Table 6). There was a statistically significant positive association in all 3 cohorts between the number of unique drugs for which a patient had prescriptions filled and inpatient admission; concomitant use of oral glucose-lowering agents and statins was also associated with a statistically significant reduction in the odds of being hospitalized. Although female sex had no significant effect on the likelihood of needing ED care, female sex was associated with lower odds of hospitalization for all 3 cohorts.

TABLE 3.
Unadjusted Bivariate Logistic Regression Results Predicting Adherence[a] Among Newly Enrolled Participants in the UNC Health Care Pharmacy Assistance Program to Medications for a Specific Chronic Disease

Characteristic/variable predicting adherence[a]	Users of antihypertensive agents (N = 866) OR (95% CI)	Users of oral glucose-lowering agents (N = 265) OR (95% CI)	Users of statins (N = 455) OR (95% CI)
Age	1.03** (1.02–1.05)	1.03** (1.01–1.06)	1.03** (1.01–1.05)
Female sex	0.99 (0.76–1.29)	0.68 (0.42–1.11)	0.84 (0.57–1.22)
White race	1.21 (0.93–1.58)	2.39** (1.46–3.94)	2.02** (1.37–2.98)
English as preferred language	1.01 (0.70–1.47)	2.18* (1.20–3.96)	1.68 (0.93–3.04)
Local residence[b]	1.46** (1.10–1.94)	1.20 (0.70–2.05)	1.19 (0.79–1.80)
No. of unique drugs received	1.19** (1.15–1.24)	1.09** (1.03–1.15)	1.08** (1.04–1.13)
Use of any antihypertensive agent	—	1.97** (1.17–3.31)	1.70* (1.10–2.63)
Use of any glucose-lowering agent	2.19** (1.54–3.12)	—	1.56* (1.04–2.35)
Use of any statin	2.92** (2.19–3.89)	2.71** (1.64–4.47)	—

Note. CI, confidence interval; UNC, University of North Carolina; OR, odds ratio.
*P<.05.
**P<.01.
[a]Adherence was defined as having an overall, aggregate proportion of days covered (PDC) equal to or greater than 0.8 for medications within a cohort.
[b]Local residence was defined as living in 1 of these 7 counties: Orange, Chatham, Alamance, Caswell, Person, Durham, or Wake.

TABLE 4.
Adjusted Multivariable Logistic Regression Results Predicting Adherence[a] Among Newly Enrolled Participants in the UNC Health Care Pharmacy Assistance Program to Medications for a Specific Chronic Disease

Characteristic/variable predicting adherence[a]	Users of antihypertensive agents (N = 866) OR (95% CI)	Users of oral glucose-lowering agents (N = 265) OR (95% CI)	Users of statins (N = 455) OR (95% CI)
Age	1.03** (1.01–1.04)	1.02 (0.99–1.05)	1.03* (1.00–1.05)
Female sex	0.84 (0.63–1.13)	0.70 (0.42–1.18)	0.74 (0.49–1.10)
White race	0.89 (0.65–1.22)	1.83* (1.05–3.21)	1.82** (1.19–2.79)
English as preferred language	0.74 (0.48–1.12)	1.07 (0.53–2.14)	1.21 (0.64–2.32)
Local residence[b]	1.31 (0.96–1.79)	1.37 (0.76–2.47)	1.23 (0.79–1.92)
No. of unique drugs received	1.17** (1.13–1.22)	1.05 (0.99–1.11)	1.06** (1.02–1.11)
Use of any antihypertensive agent	—	1.17 (0.64–2.13)	1.36 (0.85–2.16)
Use of any glucose-lowering agent	1.20 (0.81–1.79)	—	1.37 (0.89–2.12)
Use of any statin	1.80** (1.30–2.49)	1.75 (0.99–3.10)	—

Note. CI, confidence interval; OR, odds ratio; UNC, University of North Carolina.
*P<.05.
**P<.01.
[a]Adherence was defined as having an overall, aggregate proportion of days covered (PDC) equal to or greater than 0.8 for medications within a cohort.
[b]Local residence was defined as living in 1 of these 7 counties: Orange, Chatham, Alamance, Caswell, Person, Durham, or Wake.

Similar results were observed for patients whose preferred language was English, but only among users of antihypertensive agents and users of oral glucose-lowering agents. Local residence did not predict inpatient utilization.

Discussion

We examined patterns of medication adherence and health care utilization among PAP participants who received treatment for chronic disease. Because North Carolina is opting out of the Medicaid expansion offered under the ACA [25], these patients are likely to be more reliant on pharmacy assistance programs. Although the number of PAP participants in the study represents a small fraction of the estimated 1.6 million adults in North Carolina who lacked health insurance before the ACA took effect in January 2014 [30], PAP served as a primary source of pharmacy care for a large number of patients who had therapeutically complex conditions and who faced significant financial barriers to appropriate medication use.

The adherence patterns observed in this study were consistent with those of other medication use studies [2-5]. Average PDCs ranged from 0.6 to 0.7 across common chronic disease states, and roughly 40%–50% of patients were adherent to medications for their chronic conditions.

TABLE 5.
Multivariable Logistic Regression Results Predicting an Emergency Department Visit by Newly Enrolled Participants in the UNC Health Care Pharmacy Assistance Program Taking Medications for a Specific Chronic Disease

Characteristic/variable predicting an emergency department visit	Users of antihypertensive agents (N = 866) OR (95% CI)	Users of oral glucose-lowering agents (N = 265) OR (95% CI)	Users of statins (N = 455) OR (95% CI)
Adherence to cohort drugs[a]	0.77 (0.53–1.13)	0.66 (0.33–1.35)	0.86 (0.51–1.43)
Age	0.98* (0.97–1.00)	0.98 (0.94–1.01)	0.97 (0.95–1.00)
Female sex	0.95 (0.66–1.35)	0.52 (0.26–1.02)	0.99 (0.61–1.61)
White race	0.96 (0.67–1.39)	0.92 (0.44–1.90)	0.87 (0.53–1.45)
English as preferred language	2.63** (1.34–5.13)	1.61 (0.62–4.19)	2.61 (0.97–7.01)
Local residence[b]	3.28** (2.12–5.08)	3.59** (1.45–8.89)	1.95* (1.09–3.47)
No. of unique drugs received	1.12** (1.07–1.17)	1.16** (1.07–1.25)	1.09** (1.03–1.15)
Use of any antihypertensive agent	—	0.84 (0.40–1.78)	1.04 (0.60–1.80)
Use of any glucose-lowering agent	0.72 (0.45–1.16)	—	0.69 (0.40–1.19)
Use of any statin	0.69 (0.46–1.03)	0.52 (0.25–1.12)	—

Note. CI, confidence interval; OR, odds ratio; UNC, University of North Carolina.
*P<.05.
**P<.01.
[a]Adherence was defined as having an overall, aggregate proportion of days covered (PDC) equal to or greater than 0.8 for medications within a cohort.
[b]Local residence was defined as living in 1 of these 7 counties: Orange, Chatham, Alamance, Caswell, Person, Durham, or Wake.

TABLE 6.
Multivariable Logistic Regression Results Predicting An Inpatient Admission Among Newly Enrolled Participants in the UNC Health Care Pharmacy Assistance Program Taking Medications for a Specific Chronic Disease

Characteristic/variable predicting an inpatient admission	Users of antihypertensive agents (N = 866) OR (95% CI)	Users of oral glucose-lowering agents (N = 265) OR (95% CI)	Users of statins (N = 455) OR (95% CI)
Adherence to cohort drugs[a]	0.58** (0.39–0.87)	0.70 (0.32–1.51)	0.85 (0.48–1.52)
Age	1.01 (0.99–1.02)	1.00 (0.97–1.04)	0.99 (0.96–1.02)
Female sex	0.51** (0.35–0.74)	0.34** (0.16–0.74)	0.41** (0.23–0.73)
White race	0.96 (0.65–1.40)	1.33 (0.57–3.09)	0.93 (0.52–1.68)
English as preferred language	0.56* (0.33–0.93)	0.22** (0.08–0.57)	0.62 (0.27–1.44)
Local residence[b]	1.29 (0.87–1.91)	1.07 (0.49–2.35)	1.21 (0.66–2.22)
No. of unique drugs received	1.22** (1.17–1.28)	1.24** (1.14–1.36)	1.21** (1.14–1.29)
Use of any antihypertensive agent	—	0.89 (0.39–2.03)	1.01 (0.54–1.89)
Use of any glucose-lowering agent	0.55* (0.33–0.91)	—	0.40** (0.20–0.78)
Use of any statin	0.67 (0.44–1.01)	0.39* (0.16–0.92)	—

Note. CI, confidence interval; OR, odds ratio; UNC, University of North Carolina.
*$P<.05$.
**$P<.01$.
[a]Adherence was defined as having an overall, aggregate proportion of days covered (PDC) equal to or greater than 0.8 for medications within a cohort.
[b]Local residence was defined as living in 1 of these 7 counties: Orange, Chatham, Alamance, Caswell, Person, Durham, or Wake.

Notably, increased age, inclusion in multiple study cohorts, and filling prescriptions for a greater number of unique medications (which was a proxy for disease burden and therapeutic complexity) were each associated with improved odds of adherence. It is also notable that for patients taking oral glucose-lowering agents and for those taking statins, the odds of being adherent were over 80% higher for white patients compared to nonwhites.

Among PAP participants, improved medication adherence was generally associated with fewer hospitalizations and fewer ED visits across all study cohorts; however, the association between adherence and number of inpatient admissions was only statistically significant for users of antihypertensive agents. It is possible that a longer observation period and larger sample sizes could have elucidated a stronger statistical relationship between adherence and health care use. That said, observed trends in our findings suggest that improved access to medications through PAP may be associated with reduced health care utilization among low-income uninsured patients who are adherent to chronic disease therapies.

We also identified general predictors of ED care and inpatient care across the 3 study cohorts. Receiving medications for more than 1 chronic condition was associated with a decreased likelihood of health care utilization. However, filling prescriptions for a greater number of unique drugs during the observation period—a proxy for disease burden and therapeutic complexity—was associated with an increased likelihood of needing ED care or inpatient care. Interestingly, patients whose preferred language was not English were generally less likely to seek ED care than were individuals who preferred English, but the former patients were much more likely to experience a costly hospitalization.

These observations could inform administration of the UNC Health Care PAP and similar programs in 2 important ways. First, targeting older patients who have therapeutically complex conditions for enrollment in pharmacy assistance programs may represent optimal use of current program funding because those patients have a greater likelihood of adhering to therapies for the treatment of common chronic diseases. Second, clear opportunities exist to improve medication adherence and utilization among PAP participants who have chronic disease, especially those belonging to racial minorities and those whose preferred language is not English.

Charitable pharmacy assistance programs could improve adherence and patient outcomes by implementing pharmacist-delivered medication therapy management (MTM) services alongside the standard dispensing processes. To that end, in 2013 the UNC Health Care PAP implemented the Carolina Assessment of Medications Program (CAMP), a pharmacist-led MTM service, to optimize the pharmacotherapy regimens of PAP participants. CAMP participants meet face-to-face with a clinical pharmacist for a comprehensive medication review once per quarter. Additionally, CAMP pharmacists coordinate all monthly prescription refills for CAMP enrollees. Targeting these types of MTM services toward select PAP populations—such as racial minorities, patients preferring a language other than English, and patients using high numbers of medications—may improve adherence, reduce expensive health care utilization, and ultimately enhance health outcomes.

Limitations

Our study has several limitations. First, the nature of PAP and its patient population necessitated the use of a preva-

lent-user design. By including prevalent users (patients who had been taking the therapy for some time before the study began), the study cohorts may have included patients who had previously succeeded on therapy, thereby introducing a "healthy adherer" bias [31]. That said, prevalent users may be more representative of the patient populations served by charitable pharmacy assistance programs, who are seeking accessible health care for previously diagnosed conditions.

Second, the substantial overlap of patients across cohorts could have contributed to the similar trends we observed across cohorts.

Third, this study used aggregate measures of medication adherence within study cohorts, and health care utilization was measured in terms of all-cause ED visits and all-cause hospital admissions. Although these are actionable outcomes, investigating adherence to a specific drug class and investigating health care utilization attributable directly to the disease for which the cohort was being treated (hypertension, diabetes, or hyperlipidemia) would be informative and might elicit stronger statistical relationships in the analyses.

Fourth, due to data limitations, prescription use and health care utilization measures could only be captured during the 6-month observation period. Ideally, these measures would also have been observed during a baseline period prior to the index date to avoid potential simultaneity.

Finally, our data sources could not capture prescription use or health care utilization that occurred outside of the UNC Health Care system, and we may have lacked measures for potential patient-level confounders.

Conclusion

From 2009 through 2011, roughly half of participants in the UNC Health Care PAP who had chronic diseases were adherent to their long-term medications. Adherent participants, particularly those who were adherent to antihypertensive agents, were less likely to use costly health care services. Poorer adherence was associated with nonwhite race, while use of costly health care services was associated with preferring a language other than English and receiving high numbers of unique medications. Future research should focus on ways of improving medication adherence to chronic disease therapies among participants in charitable pharmacy assistance programs, especially those who have therapeutically complex conditions and those who belong to minority groups. Future research should also assess the long-term viability of such programs to ensure that they can continue to provide quality pharmacy services to low-income uninsured patient populations. NCMJ

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