Do Medical Homes Increase Medication Adherence for Persons With Multiple Chronic Conditions?

Author(s): Christopher A. Beadles, Joel F. Farley, Alan R. Ellis, Jesse C. Lichstein, Joseph P. Morrissey, C. Annette DuBard and Marisa E. Domino

Source: *Medical Care*, February 2015, Vol. 53, No. 2 (February 2015), pp. 168-176

Published by: Lippincott Williams & Wilkins

Stable URL: https://www.jstor.org/stable/10.2307/26417913

Do Medical Homes Increase Medication Adherence for Persons With Multiple Chronic Conditions?

Christopher A. Beadles, MD, PhD,†‡ Joel F. Farley, PhD,§ Alan R. Ellis, PhD, MSW,‡ Jesse C. Lichstein, PhD,† Joseph P. Morrissey, PhD,†‡ C. Annette DuBard, MD, MPH,‡‖ and Marisa E. Domino, PhD†‡*

Background: Medications are an integral component of management for many chronic conditions, and suboptimal adherence limits medication effectiveness among persons with multiple chronic conditions (MCC). Medical homes may provide a mechanism for increasing adherence among persons with MCC, thereby enhancing management of chronic conditions.

Objective: To examine the association between medical home enrollment and adherence to newly initiated medications among Medicaid enrollees with MCC.

Research Design: Retrospective cohort study comparing Community Care of North Carolina medical home enrollees to nonenrollees using merged North Carolina Medicaid claims data (fiscal years 2008–2010).

Subjects: Among North Carolina Medicaid-enrolled adults with MCC, we created separate longitudinal cohorts of new users of antidepressants (N = 9303), antihypertensive agents (N = 12,595), oral diabetic agents (N = 6409), and statins (N = 9263).

Measures: Outcomes were the proportion of days covered (PDC) on treatment medication each month for 12 months and a dichotomous measure of adherence (PDC > 0.80). Our primary analysis utilized person-level fixed effects models. Sensitivity analyses included propensity score and person-level random-effect models.

Results: Compared with nonenrollees, medical home enrollees exhibited higher PDC by 4.7, 6.0, 4.8, and 5.1 percentage points for depression, hypertension, diabetes, and hyperlipidemia, respectively (P's < 0.001). The dichotomous adherence measure showed similar increases, with absolute differences of 4.1, 4.5, 3.5, and 4.6 percentage points, respectively (P's < 0.001).

Conclusions: Among Medicaid enrollees with MCC, adherence to new medications is greater for those enrolled in medical homes.

Key Words: medical home, medication adherence, patient-centered care, comorbidity

(*Med Care* 2015;53: 168–176)

BACKGROUND

Nearly 30% of Americans have ≥2 chronic conditions.[1] This high and rising prevalence of multiple chronic conditions (MCC) represents a substantial burden for patients, caregivers, and the health care system. Persons with MCC use more care than those without MCC and account for approximately two-thirds of both prescriptions filled[1] and health care spending.[2] Yet, persons with MCC have poorer disease control,[3,4] lower functional status,[5] and greater risk for mortality than those without MCC.[1] Further, pharmacotherapy is often a primary and important component of care for people with MCC, yet medication adherence among persons with MCC is uniquely challenging due to the greater complexity of their overall medical regimens, the number of prescribing providers, and the lack of coordination among providers.[6–9] The current system of care delivery, which emphasizes management of discrete conditions, is not highly effective in preserving the health and functional status of patients with MCC.[10,11]

The medical home is intended to provide comprehensive, person-centered, and coordinated primary care with systems-based quality improvement. In doing so, the model is expected to increase access to primary care, improve the quality of care delivered, and reduce the total cost of

From the *RTI International Durham, NC; †Department of Health Policy and Management, UNC Gillings School of Global Public Health; ‡Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill; §Division of Pharmaceutical Outcomes and Policy, UNC Eshelman School of Pharmacy, University of North Carolina, Chapel Hill; and ‖Community Care of North Carolina, Raleigh, NC.

This work was supported by grant R24 HS019659-01 from the Agency for Healthcare Research and Quality (AHRQ) and North Carolina Community Care Networks and by AHRQ grant 5T32-HS000032. Additional funding for Dr Beadles was provided by grant TPP 21-023 from the U.S. Department of Veterans Affairs Office of Academic Affiliations and for Dr Lichstein by grant 2T32NR008856 from the National Institute of Nursing Research.

J.F.F. has received consulting support from Daiichi Sankyo and Takeda Pharmaceutical Company for unrelated studies. A.R.E. has received research funding from Amgen, Merck, and the UNC Center for Pharmacoepidemiology for unrelated projects. M.E.D. also receives funding from AccessCare for evaluation projects unrelated to the present manuscript. C.A.D. is employed by NCCCN. The remaining authors declare no conflict of interest.

Reprints: Christopher A. Beadles, MD, PhD, 3040 E Cornwallis Rd, Durham, NC 27709. E-mail: cbeadles@rti.org.

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Website, www.lww-medicalcare.com.

ISSN: 0025-7079/15/5302-0168

care.[12–14] Evidence supporting the potential benefits of the medical home is beginning to accrue, especially for improvements in quality of care and decreases in inappropriate utilization.[15] Although initial evidence is encouraging, potential benefits of the medical home for persons with MCC remain largely unexplored.[16]

The medical home provides a potential mechanism for improving medication adherence among persons with MCC. Enhanced care coordination can reduce the number of prescribers. Case management, including medication reconciliation, can improve clinicians' medication management. These processes may reduce pill burden and medication complexity for persons with MCC, thus improving adherence and persistence. The goal of this study was to assess the association between medical homes and adherence to newly initiated medications among Medicaid enrollees with MCC.

METHODS

Setting

Community Care of North Carolina (CCNC), the medical home program for the state's Medicaid population, began in 1998 as a primary care case management (PCCM) demonstration program and has expanded to provide enhanced PCCM statewide.[17] The program utilizes 14 regional networks of primary care providers to improve the quality, efficiency, and cost-effectiveness of care by linking Medicaid recipients to primary care medical homes.[18] Although there is variation among the 14 networks and their affiliated practices, all CCNC medical homes share a set of core components.[18] These include population management tools, evidenced-based programs and protocols, disease management, pharmacy management, case management, and regular reports of disease-specific performance metrics to physicians and networks.[17,18] The performance metrics, case management, and pharmacy management services have been particularly valuable in improving care quality.[18] CCNC medical home enrollees experience greater access to care, which translates into more encounters, more refill authorizations, and fewer undertreated or untreated conditions. In addition, the highest-risk enrollees who are discharged from hospitals receive intensive care management. This transitional care addresses the high risk for adverse events and complications, through face-to-face discharge planning with care managers embedded in large-volume hospitals, timely outpatient follow-up appointments, medication management, patient/family education, and real-time information sharing with all hospitals that serve Medicaid patients.

Patients can enroll in CCNC at the time of Medicaid eligibility determination by selecting a local medical home from a list or accepting assignment to a medical home close to their residence. After Medicaid eligibility determination a similar enrollment process can be initiated by a participating practice (with patient approval) or by the patient. During the study window, approximately 65% of the nonelderly, nondual adult Medicaid population was enrolled in CCNC. Each enrolled member was linked to 1 of 1568 participating primary care practices statewide. Medicaid enrollees not enrolled in CCNC received traditional Medicaid fee-for-service health care.

Data Sources

To better capture the medical and psychiatric history of persons with MCC, we accessed a unique data source, North Carolina Integrated Data for Researchers (NCIDR), which links North Carolina Medicaid claims data with a number of additional administrative data sources using a probabilistic linkage procedure.[19] These included Medicaid enrollment data, electronic records of state-funded mental health services, a state psychiatric hospital utilization database, and electronic records from a 5-county behavioral health carve-out program that existed during our study period. The data on state-funded mental health services and state psychiatric hospital use provide information about mental health services not routinely covered by Medicaid. The behavioral health carve-out pilot includes outpatient mental health utilization for Medicaid enrollees in 5 participating counties. From this database, we extracted information on medical home enrollment, pharmacy claims, and service utilization for fiscal years 2008 through 2010. Variables were measured at the person-month level during the 36-month study period.

Exclusion and Inclusion Criteria

We conducted a retrospective cohort study comparing medication adherence for newly initiated medications among adult nondual eligible Medicaid patients by medical home enrollment status. Elderly Medicaid beneficiaries and others dually eligible for Medicare were not included in this study, due to lack of complete pharmacy claims data. Nursing facility residents are excluded from CCNC enrollment, and thus also excluded from this study.

This study is part of a larger evaluation of the effect of the medical home on health outcomes for people with MCC. Because of the design of the larger evaluation, our initial population does not include all patients with MCC, but a select MCC population with at least ≥ 2 of the following 8 chronic conditions: major depressive disorder (ICD-9-CM codes 296.2X, 296.3X, 300.4X, 311.XX), schizophrenia (ICD-9-CM codes 295.XX), diabetes mellitus (ICD-9-CM codes 250.XX, 271.4X, 357.2X, 362.0X, 366.41, 791.5X, V4585, V5391, V6546), hypertension (ICD-9-CM codes 362.11, 401.XX-405.XX, 997.91), hyperlipidemia (ICD-9-CM codes 272.XX), seizure disorder (ICD-9-CM codes 345.XX, 780.XX excluding 780.31), asthma (ICD-9-CM codes 493.XX), and chronic obstructive pulmonary disease (COPD; ICD-9-CM codes 491.XX, 492.XX, 496.XX). These 8 conditions were selected based on high prevalence and health expenditure and were intended to cover an array of common physical and mental health conditions for which quality measures could be constructed using secondary medical claims. We required a minimum of 2 outpatient or emergency department claims or 1 inpatient claim for each chronic condition during the study period to avoid rule-out diagnoses. The population included patients with additional chronic conditions other than the 8 target conditions.

From the initial study population, we created separate cohorts of Medicaid enrollees initiating medication treatment for major depressive disorder, hypertension, diabetes mellitus, and hyperlipidemia. These 4 conditions were selected because they are usually managed in primary care settings—

the focus of medical home models—and have established claims-based adherence measures. Asthma and COPD were excluded despite being managed in a primary care setting, given difficulty in measuring adherence for inhaled medications. In addition, schizophrenia and seizure disorder were excluded because they are less likely to be actively managed by primary care providers.

Because we were unable to observe medication claims outside of Medicaid and non-Medicaid patients were not eligible for CCNC during the study period, persons were excluded if they were not continuously enrolled in Medicaid throughout the entire baseline, index month, and initial 6 months of the follow-up period. Figure 1 describes in detail the creation of the analytic cohorts.

Overlap between cohorts was allowed, and 34% of the total unique individuals were in >1 cohort during the study period. The greatest overlap was between the diabetes mellitus and hyperlipidemia cohorts (39% of new diabetes medication class users also started a new medication for hyperlipidemia at some point during the 36 mo period). Depending on cohort, only 4%–6% of individuals initiated ≥ 2 condition-specific (eg, depression and diabetes) medication classes in the same month.

Study Design

Analyses of prevalent medication users may be confounded if previous medication use has affected covariate values or if risk varies with time.[20] We used a new-user design to avoid these problems and to improve comparability between groups. A new user was defined as a patient with a claim for a new medication to treat the disease of interest (ie, an antidepressant, antihypertensive, oral diabetic agent, or statin), who had not been exposed to a medication in the same therapeutic class during a rolling 6-month baseline period preceding the month in which the initial medication claim occurred (referred to as the "index month"). Adherence to each therapeutic class was assessed during a rolling 12-month follow-up period starting the month after the index month. Thus, the total length of observation was 19 months for each cohort.

Measures

The primary outcome variable, measured monthly, was proportion of days covered (PDC) on target medication.[21] (During this time period in North Carolina, Medicaid prescriptions were limited to a 30 d supply). We used prescription claims to determine the proportion of days in each month for which dispensed medication was available.[22] For example, a patient with at least 1 antidepressant prescription fill covering 20 days in a 30-day period would have a PDC of 20/30 or 0.667 (66.7%). Patients using ≥ 2 medications or switching medications within a therapeutic class were considered exposed during days on which at least 1 medication was available. To illustrate, if a patient filled 2 antihypertensive medications and discontinued only 1, he or she would still be considered exposed to antihypertensive treatment. In addition to the continuous PDC measurement, we used a dichotomous measure of adherence (ADH), defined as PDC ≥ 0.8. Eighty percent medication adherence is commonly used as a threshold for identifying adherent patients and correlates well with clinical outcomes.[23]

Our primary explanatory variable was a dichotomous indicator of enrollment in a medical home during each month. Patients were identified as being enrolled in the program if monthly management fees to both the primary care provider and the CCNC network were identified in the claims.

Monthly control variables included number of additional target conditions (between 1 and 7 inclusive), number of additional target conditions for which a patient was receiving medication (between 1 and 7 inclusive), number of inpatient admissions, number of emergency department visits, number of outpatient visits, and 19 comorbidity indicators based on the Chronic Illness and Disability Payment System (CDPS).[24] To capture long-term changes in health care utilization, we created several time-dependent variables covering the previous 6 months: the number of additional conditions for which a patient was receiving medication, total outpatient visits, total emergency department visits, total inpatient admissions, and the CDPS score.

Statistical Analysis

We used person-level fixed effects regression to examine adherence differences between patients enrolled and not enrolled in the CCNC medical home, adjusting for the control variables defined above. Because fixed effects models only assume absence of unobserved time-varying confounding, they were considered our primary analytic approach. These models address differences in sample selection by controlling for observed and unobserved time-invariant confounding, such as severity of illness and preexisting disposition to be adherent to medications. Medical home enrollment and adherence were measured concurrently in each of the 12-monthly panel observations for each patient.

In addition to modeling the association between medical home enrollment and adherence for all patients, we also examined this association separately for new and prevalent medical home enrollees. New enrollees were identified as patients with no baseline medical home enrollment. This population is of interest because special attention may be given to patients during the initial encounter with the CCNC system, which may influence the quality of care. Similarly, prevalent enrollees were identified as patients with ≥ 3 months of medical home exposure before medication initiation. This population was thought to have a different experience than new enrollees given their prior medical home exposure.

Sensitivity Analysis

We implemented several sets of sensitivity analyses with differing analytic assumptions to assess the robustness of our primary analysis. These included a propensity score–weighted analysis (to address observed time-invariant and time-varying confounders), a panel Hausman-Taylor random-effect analysis (to address observed and unobserved time-varying confounders), and several additional variations of the primary person-level fixed effects analysis.

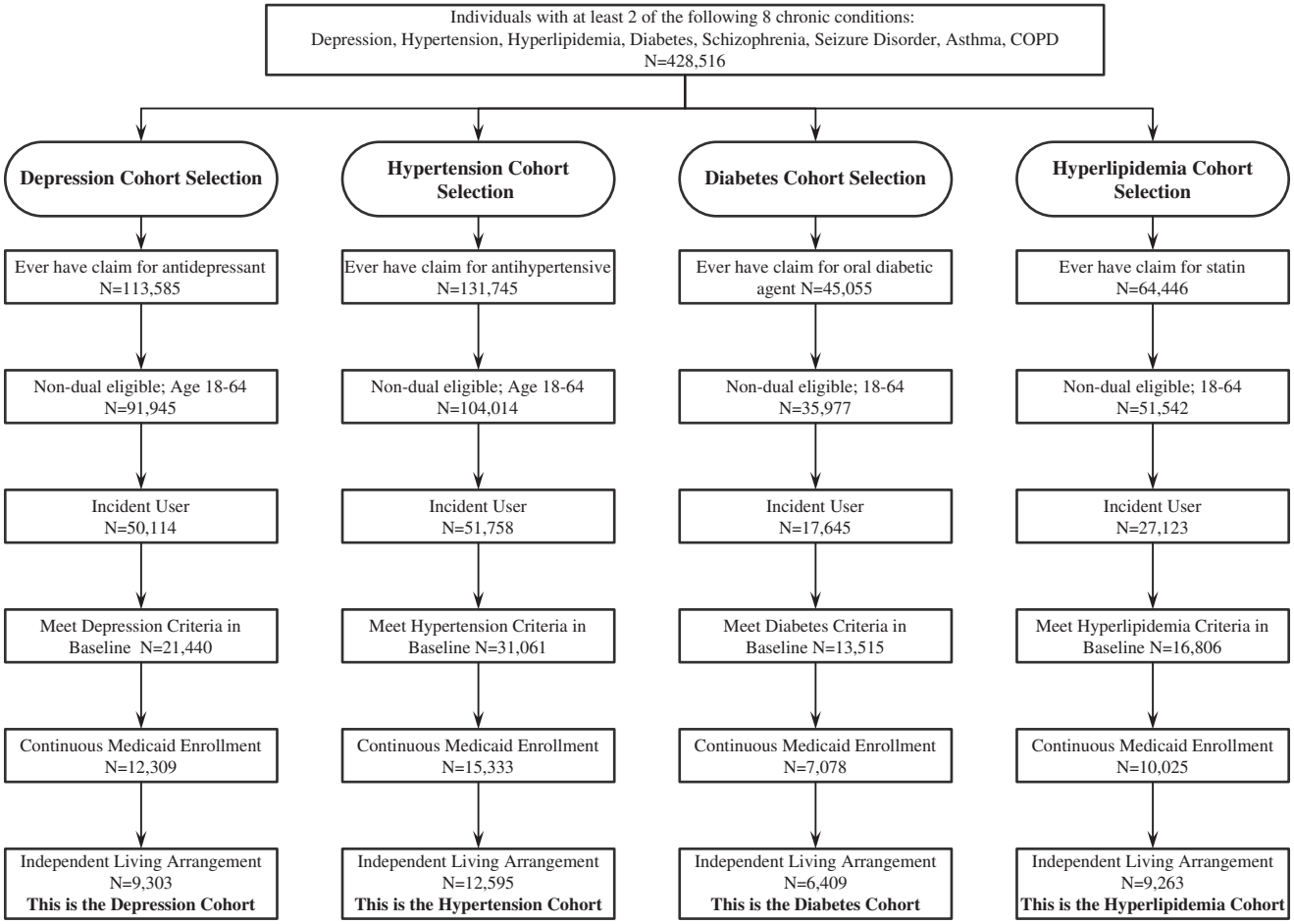

FIGURE 1. Consort diagram: description of filtering to original data to create patient cohorts for final analysis. Individuals with at least 2 of the following 8 chronic conditions: depression, hypertension, hyperlipidemia, diabetes, schizophrenia, seizure disorder, asthma, and chronic obstructive pulmonary disease (N = 428,516).

Although fixed effects models control for observed and unobserved time-invariant selection into medical homes, an alternative method to control for the potential confounding due to the voluntary nature of medical home enrollment is to generate propensity scores within each cohort to balance medical home enrollees versus nonenrollees on observed pretreatment covariates. We derived propensity scores from all control variables (described above) using generalized boosted regression and estimated the average treatment effect of the medical home using inverse-probability-of-treatment weights (IPTW, see Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/MLR/A850, for post-propensity-score-weighting covariate balance).[25–27]

We then estimated generalized estimating equations with a Poisson distribution, log link, and exchangeable correlation structure. These models accounted for within-person correlations among the 12 follow-up observations. Models were estimated for PDC and ADH. Both sets of models were at the person-month level, with IPTW based on ever (vs. never) having exposure to a medical home during the baseline period or index month. Outcome model control variables were sex, race, ethnicity, age, number of additional conditions (beyond cohort condition) for which a patient was receiving medications, and number of additional conditions (beyond cohort condition).

We also implemented person-level Hausman-Taylor random-effect models, which controlled for observed and unobserved time-varying confounders such as unobserved rapidly changing disease severity. Models were implemented for PDC and ADH. Finally, to examine whether medical home initiation was associated with PDC and ADH above and beyond the association of current-month medical home use, we added a variable to our fixed effects models indicating whether the patient was in his or her first month of medical home exposure.

For ease of interpretation, we report the results of our outcome models as average marginal effects, rather than conditional estimates. The study protocol was approved by the University of North Carolina Institutional Review Board.

RESULTS

Descriptive Results

Table 1 provides baseline characteristics stratified by cohort and medical home status. Medical home enrollees and

TABLE 1. Descriptive Statistics at Baseline

Variables	Mean (SD) or %		Standardized Difference	*P*
	Nonmedical Home	Medical Home		
Depression	N = 3325	N = 5978		
Age	40.5 (12.0)	40.1 (11.7)	3.8	0.081
Male	24.6	22.3	5.4	0.010
White	60.7	53.1	18.2	< 0.001
Black	33.4	40.8	18	
Asian	0.3	0.3	1.5	
American Indian	2.4	2.5	0.1	
Hispanic	2.0	2.2	0.4	0.850
Mental health carve-out	3.5	7.1	14.6	< 0.001
Total no. ED visits	1.7 (3.1)	1.5 (2.8)	5.8	0.006
Total no. outpatient visits	6.9 (7.1)	7.4 (7.6)	5.8	0.008
Total no. conditions	1.0 (1.0)	1.0 (1.0)	2.9	0.180
Total no. medications	3.1 (2.4)	2.9 (2.3)	10.7	< 0.001
CDPS	4.1 (2.4)	4.3 (2.3)	7.8	< 0.001
Hyperlipidemia	N = 2965	N = 6298		
Age	48.3 (9.5)	47.2 (9.9)	9.2	< 0.001
Male	36.1	31.1	10.5	< 0.001
White	56.6	48.7	15.9	
Black	35.3	42.1	14.0	
Asian	1.0	0.7	3.5	
American Indian	2.3	2.5	1.3	
Hispanic	2.2	2.6	2.4	0.302
Mental health carve-out	3.9	8.0	17.2	< 0.001
Total no. ED visits	1.0 (2.3)	1.0 (2.2)	3.2	0.151
Total no. outpatient visits	6.3 (6.8)	6.8 (7.5)	6.1	0.008
Total no. conditions	1.3 (1.2)	1.2 (1.2)	8.3	< 0.001
Total no. medications	3.3 (2.2)	3.1 (2.1)	10.4	< 0.001
CDPS	4.2 (2.4)	4.4 (2.3)	6.5	0.004
Hypertension	N = 4821	N = 7774		
Age	46.0 (10.8)	44.2 (11.0)	16.9	< 0.001
Male	37.4	31.9	11.6	< 0.001
White	49.0	42.4	13.2	< 0.001
Black	44.8	51.0	12.4	
Asian	0.5	0.5	0.7	
American Indian	2.1	2.3	1.6	
Hispanic	1.9	1.7	1.9	0.301
Mental health carve-out	3.1	6.6	16.5	< 0.001
Total no. ED visits	1.3 (2.8)	1.2 (2.6)	2.6	0.153
Total no. outpatient visits	5.2 (6.2)	6.0 (7.4)	10.7	< 0.001
Total no. conditions	1.0 (1.1)	0.9 (1.0)	10.3	< 0.001
Total no. medications	3.3 (2.6)	2.8 (2.4)	19.6	< 0.001
CDPS	3.6 (2.6)	3.8 (2.4)	7.6	< 0.001
Diabetes mellitus	N = 2251	N = 4158		
Age	46.8 (10.9)	46.0 (10.6)	7.7	0.003
Male	32.7	28.2	9.9	< 0.001
White	48.2	42.0	12.6	< 0.001
Black	44.3	50.0	11.4	
Asian	0.9	0.6	4.1	
American Indian	1.6	2.3	4.8	
Hispanic	3.1	2.0	7.0	0.006
Mental health carve-out	3.2	7.1	17.6	< 0.001
Total no. ED visits	1.1 (2.2)	1.1 (2.3)	2.2	0.412
Total no. outpatient visits	6.1 (7.9)	6.7 (8.4)	8.3	0.002
Total no. conditions	1.3 (1.3)	1.3 (1.2)	4.9	0.061
Total no. medications	3.4 (2.3)	3.1 (2.1)	13.4	< 0.001
CDPS	4.1 (2.5)	4.4 (2.5)	10.8	< 0.001

P-value for differences between medical homes enrollees and other Medicaid enrollees determined by χ^2 test for binary variables, *t* test for continuous variables, and Wilcoxon rank-sum for CDPS. Absolute standardized differences are expressed as percentages.

CDPS indicates chronic disability payment score; ED, emergency department.

nonenrollees differed greatly with respect to race and participation in the mental health carve-out. Modest but statistically significant differences were observed for age, sex, emergency department visits, outpatient visits, and number of medications. Average PDC during follow-up (not shown) was 40% (SD 43%), 50% (SD 43%), 49% (SD 43%), and 47% (SD 43%), for the depression, hypertension, diabetes, and hyperlipidemia controls, respectively. The proportion of

controls who were adherent (not shown) was 0.31 (SD 0.003), 0.41 (SD 0.002), 0.40 (SD 0.003), and 0.38 (SD 0.003), respectively. During follow-up, 39% of those not enrolled in a medical home during the index month had ≥ 1 months of medical home enrollment during follow-up. Similarly, 21% of those enrolled in a medical home during the index month had ≥ 1 months not in a medical home during follow-up. Our panel analyses took into account this variation in exposure.

Regression Results

Our primary analysis demonstrated positive associations between medical home enrollment and PDC for all cohorts (Fig. 2 and Supplemental Cohort Tables, Supplemental Digital Content 2, http://links.lww.com/MLR/A851). Medical home enrollees with depression, hypertension, diabetes, and hyperlipidemia had 4.7% points, 6.0% points, 4.8% points, and 5.1% points (P's < 0.001) higher PDC values than nonenrollees. In all cohorts, increases in PDC were larger for prevalent medical home enrollees than for new enrollees. For example, in the hypertension cohort, medical home enrollment was associated with a 6.0% point increase in PDC for prevalent enrollees and only a 3.0% point (P's < 0.001) increase in PDC for new enrollees, compared with nonmedical home enrollees. Individuals in medical homes also had a greater probability of being adherent as measured by the binary adherence measure (Fig. 3 and Supplemental Cohort Tables, Supplemental Digital Content 2, http://links.lww.com/MLR/A851). Medical home enrollees with depression, hypertension, diabetes, and hyperlipidemia had a 4.1% point, 4.5% point, 3.5% point, and 4.6% point (P's < 0.001) greater probability of reaching 80% adherence, respectively, compared with nonmedical home enrollees.

Sensitivity Analysis Results

Estimated effects for the IPTW generalized estimating equations PDC model were generally modestly smaller than results in our primary analysis, but statistically significant in all cohorts (Fig. 4 and Supplemental Cohort Tables, Supplemental Digital Content 2, http://links.lww.com/MLR/A851). For example, medical home enrollment during the current month was associated with a 5.5% point increase in the PDC for antihypertensive medications and a 4.7% point (P's < 0.001) increase in the PDC for hyperlipidemia agents. The results of the person-level Hausman-Taylor random-effect models were generally similar to those of our primary analysis (Fig. 4 and Supplemental Cohort Tables, Supplemental Digital Content 2, http://links.lww.com/MLR/A851). However, the sensitivity analysis results for the new medical home enrollees were more heterogenous than for all enrollees or prevalent enrollees, likely due to substantially smaller sample sizes. Finally, our alternate fixed effects model specification that included a binary indicator variable for the first month enrolled in a medical home exhibited a positive association between medical home enrollment and PDC for

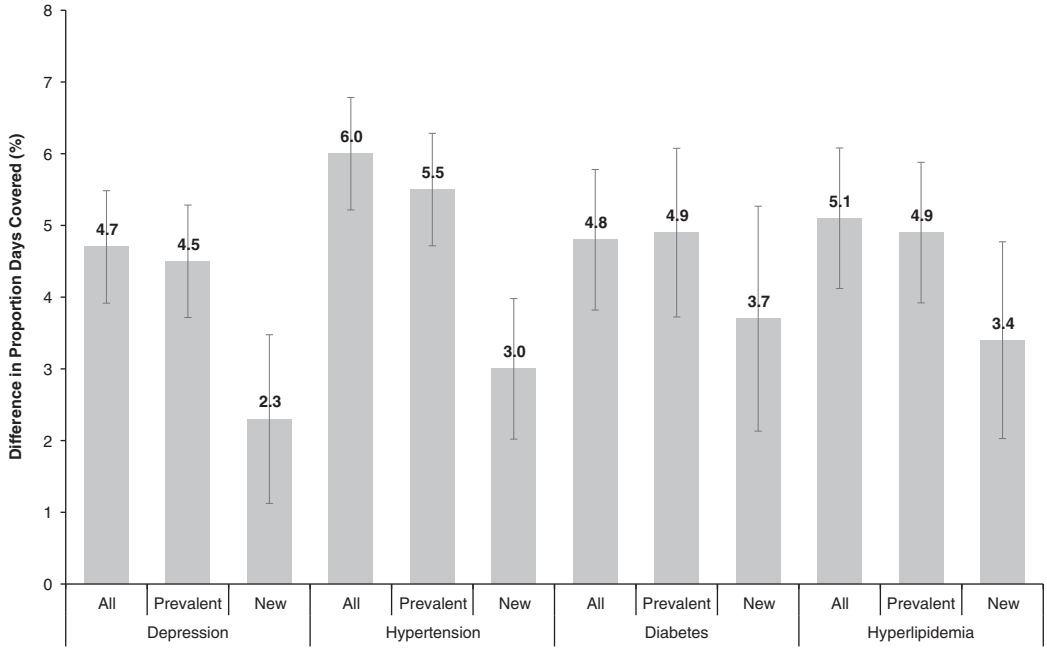

FIGURE 2. Adjusted difference in PDC associated with current-month medical home exposure, by cohort and medical home exposure history. Prevalent enrollees (with ≥ 3 mo medical home exposure before initiating medication) and new enrollees (with no medical home exposure before initiating medication) are subsets of all enrollees; persons with 1–2 months of medical home enrollment during baseline are not separately analyzed. Each column represents the absolute difference in PDC (% points) for people enrolled in medical homes in the current month, compared with people not enrolled. Error bars represent 95% confidence interval. All models control for month of follow-up, number of medications, lagged inpatient, and lagged outpatient utilization. Time-invariant characteristics are incorporated into the model fixed effect. PDC indicates proportion of days covered.

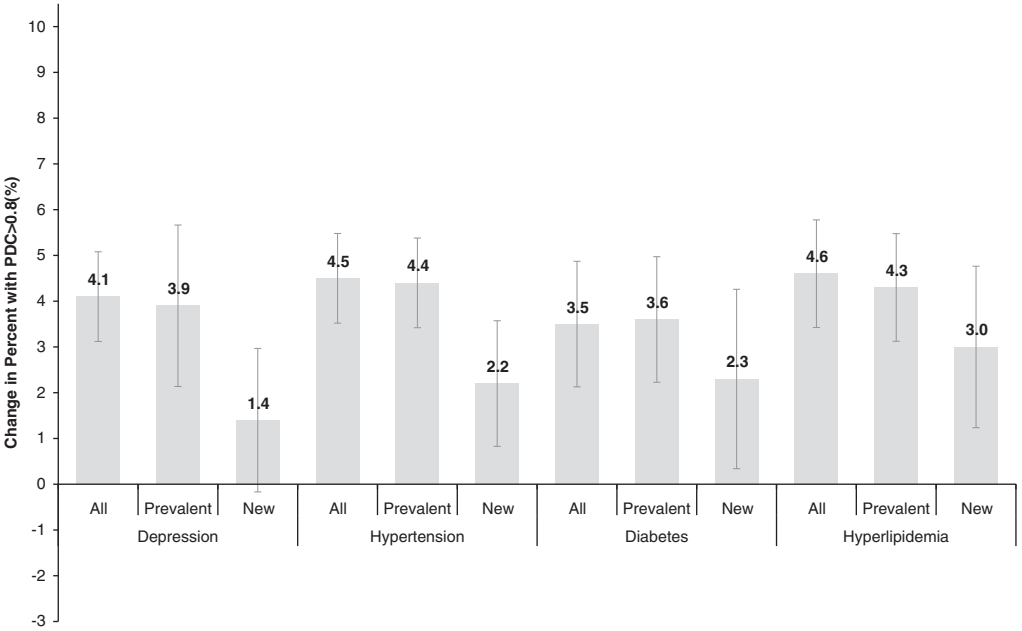

FIGURE 3. Adjusted difference in dichotomous adherence measure associated with current-month medical home exposure, by cohort and medical home exposure history. Prevalent enrollees (with ≥ 3 mo medical home exposure before initiating medication) and new enrollees (with no medical home exposure before initiating medication) are subsets of all enrollees; persons with 1–2 months of medical home enrollment during baseline are not separately analyzed. Each column represents the absolute difference (%) in the dichotomous adherence measure for people enrolled in medical homes in the current month, compared with people not enrolled. Error bars represent 95% confidence interval. All models control for month of follow-up, number of medications, lagged inpatient utilization, and lagged outpatient utilization. Time-invariant characteristics are incorporated into the model fixed effect. PDC indicates proportion of days covered.

all cohorts, with a mixed signal from the binary first-month indicator. The first-month indicator was not significant for depression or diabetes, modestly negative for hypertension, and modestly positive for hyperlipidemia (results not shown).

DISCUSSION

The medical home is intended to improve care systematically and to provide comprehensive, person-centered, and coordinated primary care. The CCNC medical home model emphasizes enhanced care coordination and case management, which have been suggested as strategies to improve quality of care for persons with MCC. This care model, as described above, provides a potential mechanism for improved medication monitoring by clinicians and improved medication adherence and persistence among persons with MCC.

We examined data from North Carolina Medicaid enrollees with MCC and observed generally low rates of therapeutic class adherence, consistent with other Medicaid studies[28,29] and with the tendency for patients with MCC to have lower adherence than other patients.[30] In our depression, hypertension, diabetes, and hyperlipidemia cohorts, medical home enrollees had higher PDC than did nonmedical home enrollees. We observed similar increases in our dichotomous measure of adherence. These findings were robust to several sets of sensitivity analyses.

Although little is known concerning the medical home and medication adherence for persons with MCC, prior work among privately insured patients in North Carolina demonstrated slightly smaller increases in therapeutic drug class adherence (1.4%–3.2% at 1 y) following elimination of copayments for generic prescriptions.[31] Given the intensity of the medical home intervention and the low cost of generic prescriptions in Medicaid, we might expect larger increases in adherence. The moderate increases in adherence for medical home enrollees are encouraging, but the clinical significance of these increases in this population is unclear. Our findings may signal an opportunity for greater implementation of care coordination and other components of the medical home model among Medicaid enrollees with MCC. North Carolina's current payment system does not incentivize adherence, and its relatively modest payments may not compete with the heavy and increasing demands on primary care providers who treat this patient population. However, Accountable Care Organizations, which provide a mechanism for shared savings from more efficient treatment, may provide sufficient financial incentives, centralized structure, and patient-directed efforts to achieve greater improvements in medication adherence. If patient panel adherence measures or patient total cost measures were sufficiently incentivized in these organizations, creating greater provider accountability, larger increases in adherence might be possible.

Alternatively, innovative medical home interventions might yield greater improvements in adherence. One process

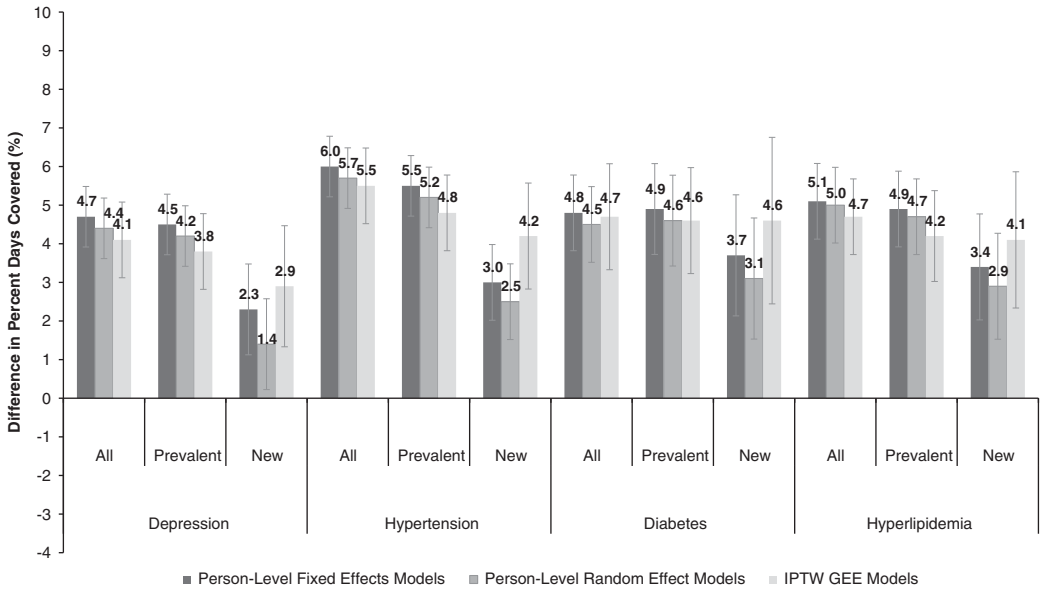

FIGURE 4. Adjusted difference in PDC associated with current-month medical home exposure, by cohort and medical home exposure history. IPTW GEE models are inverse-probability-of-treatment-weighted generalized estimating equations. Prevalent enrollees (with ≥ 3 mo medical home exposure before initiating medication) and new enrollees (with no medical home exposure before initiating medication) are subsets of all enrollees; persons with 1–2 months of medical home enrollment during baseline are not separately analyzed. Each column represents the absolute difference in PDC (% points) for people enrolled in medical homes in the current month, compared with people not enrolled. Error bars represent 95% confidence interval. All models control for month of follow-up, number of medications, lagged inpatient utilization, and lagged outpatient utilization. Time-invariant characteristics are incorporated into the model fixed effect, or as covariates (eg, sex, ethnicity) in GEE and random-effect models. PDC indicates proportion of days covered.

known to improve medication adherence and clinical outcomes among patients with chronic health conditions is the incorporation of a pharmacist into primary care.[32,33] There is an increasing call to embed pharmacists into the medical home model.[34,35] Although the CCNC model includes pharmacists as members of each network, greater pharmacist participation and more patient encounters may be required to maximize adherence in this complex population. Further efforts to optimally leverage pharmacists as an additional resource within the medical home model may be warranted. Such efforts might include regular one-on-one medication therapy management and medication reconciliation with embedded clinical pharmacists.

LIMITATIONS

This study has several limitations. First, we derived measures of adherence from claims data rather than observing actual medication use. Second, to capture all medication claims we required 13 months of continuous Medicaid enrollment and excluded Medicare enrollees; therefore, findings may not generalize to patients who are "dual eligible" or have short-term Medicaid enrollment. Third, our primary analysis assumes the absence of unmeasured time-varying confounding (sample selection); violation of this assumption could result in biased estimates. In particular, rapidly changing disease severity is unobservable in claims data and may be an important unmeasured confounder if correlated with medical home participation. However, our sensitivity analyses included a propensity score weighting approach and a random-effects approach. These analyses, based on different assumptions than the primary analysis, confirmed a positive signal from medical home enrollment.

CONCLUSIONS

We used a new-user design, examined both mental and physical chronic health conditions, and conducted a robust analysis of medication adherence among North Carolina Medicaid members initiating medications for 1 of 4 chronic conditions. We found generally positive associations between medical home enrollment and PDC, suggesting that medical home enrollment is associated with increased therapeutic class adherence among persons with MCC initiating medications. This increase in adherence is larger among individuals with a history of medical home enrollment before initiating medication.

REFERENCES

1. Anderson G. Chronic conditions: making the case for ongoing care. 2010. Available at: http://www.rwjf.org/content/dam/farm/reports/reports/2010/rwjf54583. Accessed May 4, 2012.
2. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med*. 2002;162:2269–2276.
3. Wong ND, Lopez V, Tang S, et al. Prevalence, treatment, and control of combined hypertension and hypercholesterolemia in the United States. *Am J Cardiol*. 2006;98:204–208.
4. Kerr EA, Heisler M, Krein SL, et al. Beyond comorbidity counts: how do comorbidity type and severity influence diabetes patients' treatment priorities and self-management? *J Gen Intern Med*. 2007;22:1635–1640.

5. Bayliss EA, Ellis JL, Steiner JF. Barriers to self-management and quality-of-life outcomes in seniors with multimorbidities. *Ann Fam Med*. 2007;5:395–402.
6. Chapman RH, Benner JS, Petrilla AA, et al. Predictors of adherence with antihypertensive and lipid-lowering therapy. *Arch Intern Med*. 2005;165:1147–1152.
7. Choudhry NK, Fischer MA, Avorn J, et al. The implications of therapeutic complexity on adherence to cardiovascular medications. *Arch Intern Med*. 2011;171:814–822.
8. Claxton AJ, Cramer J, Pierce C. A systematic review of the associations between dose regimens and medication compliance. *Clin Ther*. 2001;23: 1296–1310.
9. Ingersoll KS, Cohen J. The impact of medication regimen factors on adherence to chronic treatment: a review of literature. *J Behav Med*. 2008;31:213–224.
10. Geyman JP. Disease management: panacea, another false hope, or something in between? *Ann Fam Med*. 2007;5:257–260.
11. Peikes D, Chen A, Schore J, et al. Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries: 15 randomized trials. *JAMA*. 2009;301: 603–618.
12. Hussey PS, Eibner C, Ridgely MS, et al. Controlling US health care spending—separating promising from unpromising approaches. *N Engl J Med*. 2009;361:2109–2111.
13. Fields D, Leshen E, Patel K. Analysis & commentary. Driving quality gains and cost savings through adoption of medical homes. *Health Aff (Millwood)*. 2010;29:819–826.
14. Rosenthal MB, Beckman HB, Forrest DD, et al. Will the patient-centered medical home improve efficiency and reduce costs of care? A measurement and research agenda. *Med Care Res Rev*. 2010;67: 476–484.
15. Peikes D, Zutshi A, Genevro JL, et al. Early evaluations of the medical home: building on a promising start. *Am J Manag Care*. 2012;18: 105–116.
16. Sidorov JE. The patient-centered medical home for chronic illness: is it ready for prime time? *Health Aff (Millwood)*. 2008;27:1231–1234.
17. Willson CF. Building primary care medical homes within the community care of North Carolina program. *N C Med J*. 2009;70: 231–236.
18. Dobson LA Jr, Hewson DL. Community care of North Carolina—an enhanced medical home model. *N C Med J*. 2009;70:219–224.
19. Jaro MA. Probabilistic linkage of large public health data files. *Stat Med*. 1995;14:491–498.
20. Ray WA. Evaluating medication effects outside of clinical trials: new-user designs. *Am J Epidemiol*. 2003;158:915–920.
21. Martin BC, Wiley-Exley EK, Richards S, et al. Contrasting measures of adherence with simple drug use, medication switching, and therapeutic duplication. *Ann Pharmacother*. 2009;43:36–44.
22. Benner JS, Glynn RJ, Mogun H, et al. Long-term persistence in use of statin therapy in elderly patients. *JAMA*. 2002;288:455–461.
23. Hansen RA, Kim MM, Song L, et al. Comparison of methods to assess medication adherence and classify nonadherence. *Ann Pharmacother*. 2009;43:413–422.
24. Kronick R, Gilmer T, Dreyfus T, et al. Improving health-based payment for Medicaid beneficiaries: CDPS. *Health Care Financ Rev*. 2000;21:29–64.
25. Brookhart MA, Schneeweiss S, Rothman KJ, et al. Variable selection for propensity score models. *Am J Epidemiol*. 2006;163:1149–1156.
26. McCaffrey DF, Ridgeway G, Morral AR. Propensity score estimation with boosted regression for evaluating causal effects in observational studies. *Psychol Methods*. 2004;9:403–425.
27. Robins JM, Hernan MA, Brumback B. Marginal structural models and causal inference in epidemiology. *Epidemiology*. 2000;11:550–560.
28. Domino ME, Martin BC, Wiley-Exley E, et al. Increasing time costs and copayments for prescription drugs: an analysis of policy changes in a complex environment. *Health Serv Res*. 2011;46:900–919.
29. Khanna R, Pace PF, Mahabaleshwarkar R, et al. Medication adherence among recipients with chronic diseases enrolled in a state Medicaid program. *Popul Health Manag*. 2012;15:253–260.
30. Nichol MB, Knight TK, Priest JL, et al. Nonadherence to clinical practice guidelines and medications for multiple chronic conditions in a California Medicaid population. *J Am Pharm Assoc (2003)*. 2010;50: 496–507.
31. Farley JF, Wansink D, Lindquist JH, et al. Medication adherence changes following value-based insurance design. *Am J Manag Care*. 2012;18:265–274.
32. Carter BL, Ardery G, Dawson JD, et al. Physician and pharmacist collaboration to improve blood pressure control. *Arch Intern Med*. 2009;169:1996–2002.
33. Finley PR, Rens HR, Pont JT, et al. Impact of a collaborative pharmacy practice model on the treatment of depression in primary care. *Am J Health Syst Pharm*. 2002;59:1518–1526.
34. Kozminski M, Busby R, McGivney MS, et al. Pharmacist integration into the medical home: qualitative analysis. *J Am Pharm Assoc (2003)*. 2011;51:173–183.
35. Smith M, Bates DW, Bodenheimer T, et al. Why pharmacists belong in the medical home. *Health Aff (Millwood)*. 2010;29:906–913.