Do Medical Homes Improve Quality of Care for Persons with Multiple Chronic Conditions?

*Karen E. Swietek , Marisa Elena Domino ,
Christopher Beadles, Alan R. Ellis, Joel F. Farley, Lexie R. Grove,
Carlos Jackson, and C. Annette DuBard*

Objective. To examine the association between medical home enrollment and receipt of recommended care for Medicaid beneficiaries with multiple chronic conditions (MCC).

Data Sources/Study Setting. Secondary claims data from fiscal years 2008–2010. The sample included nonelderly Medicaid beneficiaries with at least two of eight target conditions (asthma, chronic obstructive pulmonary disease, diabetes, hypertension, hyperlipidemia, seizure disorder, major depressive disorder, and schizophrenia).

Study Design. We used linear probability models with person- and year-level fixed effects to examine the association between patient-centered medical home (PCMH) enrollment and nine disease-specific quality-of-care metrics, controlling for selection bias and time-invariant differences between enrollees.

Data Collection Methods. This study uses a dataset that links Medicaid claims with other administrative data sources.

Principal Findings. Patient-centered medical home enrollment was associated with an increased likelihood of receiving eight recommended mental and physical health services, including A1C testing for persons with diabetes, lipid profiles for persons with diabetes and/or hyperlipidemia, and psychotherapy for persons with major depression and persons with schizophrenia. PCMH enrollment was associated with overuse of short-acting β -agonists among beneficiaries with asthma.

Conclusions. The PCMH model can improve quality of care for patients with multiple chronic conditions.

Key Words. Medical homes, quality, multimorbidity, chronic conditions

Caring for patients with multiple chronic conditions (MCC) is a priority for the US health care system. Half (51.70 percent) of all Americans have at least one chronic condition, and almost a third (31.50 percent) have MCC (Gerteis

et al. 2014). Patients with MCC utilize health care services more frequently and access a wider range of services than the general population (Vogeli et al. 2007; Anderson 2010; Parekh and Barton 2010), are at greater risk for disability, and are more likely to be hospitalized annually (Anderson 2010). Given the complexity of caring for this population, policy makers and providers are advocating improved models of care delivery emphasizing coordination of primary, acute, behavioral, and long-term care (Anand and Parekh 2014).

One such model is the patient-centered medical home (PCMH), a model for primary care transformation that offers enhanced care coordination and disease management with the goal of improving outcomes, safety, system efficiency, and patient and provider experiences (Wagner 2001; Jackson et al. 2013; Fillmore et al. 2014). A growing body of research suggests that the PCMH may improve overall quality of care (Jackson et al. 2013). Furthermore, there is evidence that populations most likely to benefit from this model include patients with chronic conditions requiring long-term management (Akinci and Patel 2014). The PCMH model's emphasis on coordination of care may also be particularly beneficial for patients with MCC, who have more complex health care needs and use more health resources than those with a single chronic condition (Grembowski et al. 2014; Maciejewski and Bayliss 2014). A 2015 study found that, among Medicaid enrollees with MCC, adherence to new medications (including antidepressants, antihypertensive agents, oral diabetic agents, and statins) was uniformly greater for those enrolled in medical homes (Beadles et al. 2015).

However, there is a dearth of evidence on the impact of the PCMH on process quality metrics for nonelderly adults with MCC; many studies assessing PCMH impact on chronic illness care are limited to older adults (Boult et al. 2008, 2010; Peikes et al. 2009; Williams et al. 2012). The objective of this analysis was to examine the association between PCMH enrollment and receipt of disease-specific quality measures for nonelderly Medicaid beneficiaries with MCC.

Address correspondence to Karen E. Swietek, Ph.D., NORC at the University of Chicago, 225 Friend Street, Suite 204, Boston, MA 02114; e-mail: kswietek@live.unc.edu. Marisa Elena Domino, Ph.D., and Lexie R. Grove, M.S.P.H., are with the Department of Health Policy and Management, The Gillings School of Global Public Health, The University of North Carolina at Chapel Hill, Chapel Hill, NC. Christopher Beadles, M.D., Ph.D., is with the Health Care Quality and Outcomes Program, RTI International, Research Triangle Park, NC. Alan R. Ellis, Ph.D., M.S.W., is with the Department of Social Work, North Carolina State University, Raleigh, NC. Joel F. Farley, Ph.D., is with the College of Pharmacy, University of Minnesota, Minneapolis, MN. Carlos Jackson, Ph.D., is with the Community Care of North Carolina, Inc., Raleigh, NC. C. Annette DuBard, M.D., M.P.H., is with the Aledade, Inc., Bethesda, MD.

METHODS

Sample

The setting for this evaluation was Community Care of North Carolina (CCNC), a regional primary care PCMH program in North Carolina. The program includes 14 not-for-profit care networks that aim to improve quality, efficiency, and cost-effectiveness by connecting Medicaid beneficiaries to PCMHs. As of 2013, CCNC included over 1600 primary care practices in North Carolina, which collectively cared for approximately 1.2 million of the state's Medicaid recipients (Dobson and Hewson 2009). A 2014 study found that among nonelderly adults with MCC, annual medical home participation was 73.3 percent. On average, this population had 3.5 medical home visits per year, including enrollees without any visits (Lichstein et al. 2014). Providers contract with the North Carolina Department of Medical Assistance to participate in the state's Medicaid primary care case management program, then contract with a local community care network to participate in CCNC. Requirements for participation include providing primary preventive care services, assuring 24-hour coverage, coordinating referrals to specialty care, and participating in care management and quality improvement activities (McCarthy and Mueller 2010).

While some variation exists between networks, all CCNC practices share a common set of components, including population management tools, disease management, pharmacy management, case management, evidence-based programs and protocols, and regular reporting of performance metrics (Willson 2009). Both practices and networks are paid a nominal per-member-per-month payment to help coordinate care and serve as a medical home; this payment is not tied to any quality metric. Beneficiaries may enroll in CCNC at the time of Medicaid eligibility determination by either selecting a local PCMH from a list of options or accepting assignment to a PCMH close to their residence. A similar enrollment process can also be initiated after Medicaid eligibility determination by a beneficiary or by a participating practice with beneficiary consent. Medicaid beneficiaries not enrolled in CCNC receive traditional Medicaid fee-for-service primary care (Dobson and Hewson 2009).

This analysis uses the North Carolina Integrated Data for Researchers, a unique dataset from fiscal years 2008–2010 that links North Carolina Medicaid claims with other administrative data sources including Medicaid enrollment data, electronic records of state-funded mental health services, a state

psychiatric hospital utilization database, and electronic records from a five-county behavioral health carve-out program (Dubard 2013; Domino et al. 2014). The sample for this analysis is limited to adults between the ages of 18 and 64 with at least two of eight target chronic conditions for which the medical home would have a range of anticipated effects on measures of utilization and quality, including asthma, chronic obstructive pulmonary disease, diabetes, hypertension, hyperlipidemia, seizure disorder, major depressive disorder, and schizophrenia. These conditions were selected based on prevalence, costliness, immediacy of treatment effects, and feasibility of constructing claims-based quality measures. The two mental health conditions were selected specifically because they have well-developed treatment guidelines.

Because PCMH enrollment required Medicaid enrollment during the study period, the sample is limited to person-years with at least partial Medicaid eligibility. Including partial years of Medicaid eligibility increases the generalizability of the study results because a significant proportion of Medicaid beneficiaries change eligibility status at some point during a calendar year. We also conducted a sensitivity analysis requiring continuous yearly Medicaid enrollment to test whether results were driven by individuals enrolled for a full year. Dual enrollees in Medicare and Medicaid were excluded due to potentially incomplete utilization data. We assessed disease-specific quality measures for subsamples of individuals with diabetes, asthma, hyperlipidemia, hypertension, major depression, and schizophrenia. To confirm diagnoses, we required individuals to have at least two outpatient or ED visits or at least one inpatient visit for a given condition to be included in these subsamples.

Measures

We examined nine claims-based disease-specific quality measures, defined in Table 1, selected based on Healthcare Effectiveness Data and Information Set (HEDIS) measures, a review of the literature, and observability in administrative claims data. Diabetes-specific quality measures included hemoglobin A1C testing, attention for nephropathy, eye examinations, and liver function tests. Lipid profiles were assessed for individuals with either diabetes or hypertension. Receipt of angiotensin-converting enzyme inhibitor (ACE) or angiotensin receptor blocker (ARB) was assessed for individuals with both diabetes and hypertension. Short-acting β -agonist (SABA) overuse was assessed for individuals with asthma—unlike the other indicators, an increase

Table 1: Disease-Specific Quality Indicators

<i>Subpopulation</i>	<i>Quality Measure(s)</i>	<i>Source</i>
Diabetes	A1C testing	HEDIS Agency for Healthcare Research and Quality (AHRQ 2015a)
	Attention for nephropathy	HEDIS Agency for Healthcare Research and Quality (AHRQ 2015b)
	Eye examinations	HEDIS Agency for Healthcare Research and Quality (AHRQ 2014)
Diabetes or hyperlipidemia	Liver function tests	McKenney et al. (2006)
Diabetes and hypertension	Lipid profile	HEDIS
	Angiotensin-converting enzyme inhibitor (ACE) or angiotensin-receptor blocker (ARB)	American Diabetes Association (Arauz-Pacheco, Parrott, and Raskin 2004)
Asthma	SABA overuse (4 + canister equivalents in 3-month period)	Priest et al. (2011)
Major depressive disorder	Any psychotherapy	American Psychiatric Association (Gelenberg et al. 2010)
Schizophrenia	Any psychotherapy	American Psychiatric Association (Lehman et al. 2004)
	Assertive community treatment (ACT)	Schizophrenia Patient Outcomes Research Team (Dixon et al. 2010)

in this measure indicates a reduction in quality. Psychotherapy was assessed separately for individuals with major depressive disorder and individuals with schizophrenia. Finally, receipt of assertive community treatment (ACT) was assessed for individuals with schizophrenia. ACT involves a community-based group of medical, behavioral health, and rehabilitation professionals who use a team approach to meet the needs of an individual with severe and persistent mental illness and is considered an evidence-based practice for those at risk of hospitalization. Services are flexible and vary based on an individual's changing needs over time (NC Department of Health and Human Services 2018). Following HEDIS guidelines, each measure is a binary indicator of receipt of a given service during a 12-month period, except for SABA overuse, which was defined as four or more canister equivalents dispensed in a three-month period (Priest et al. 2011). PCMH enrollment was defined as any period of enrollment during the year.

Statistical Analysis

We estimated linear probability models with person and year fixed effects to examine differences in the receipt of disease-specific quality measures between individuals ever enrolled and not enrolled in PCMHs during the year. Fixed-effects models control for observed and unobserved time-invariant confounders, such as baseline severity of illness, level of education, or race. Additionally, we controlled for the number of months of Medicaid enrollment in each year. Finally, patient age was included in the fixed-effects models as a time-varying covariate. We conducted sensitivity analyses excluding person-years with 12 months of PCMH enrollment to examine the impact of PCMH enrollment on quality measures for new or intermittent enrollees.

RESULTS

The final sample (Table 2) included 131,036 unique individuals contributing a total of 208,122 person-years. Approximately 70 percent of observations were accounted for by PCMH enrollees. The average age for the full sample was 43, and this was comparable between PCMH and non-PCMH groups. We observed significant differences in other baseline characteristics between the two groups, confirming a need to control for observable and nonobservable time-invariant selection differences using person-level fixed effects. Men accounted for a smaller proportion of observations in the PCMH group (30.20 percent) than in the non-PCMH group (37.60 percent). PCMH enrollees were more likely to be nonwhite; 51.60 percent of beneficiaries in PCMHs were nonwhite compared to 46.30 percent of nonenrollees. On average, PCMH enrollees had 11.32 total comorbidities, compared to 10.17 comorbidities in the non-PCMH group. Of the 8 target conditions, a smaller proportion of PCMH enrollees had a diagnosis of diabetes, hypertension, hyperlipidemia, chronic obstructive pulmonary disease (COPD), seizure disorder, and schizophrenia, and a slightly larger proportion had diagnoses of asthma and major depression compared to non-PCMH-enrolled individuals.

In unadjusted comparisons, individuals enrolled in a PCMH were more likely to receive all recommended services but were also more likely to over-use SABAs (Table 3). These differences were all statistically significant at the $p < .001$ level, except for receipt of ACT for individuals with schizophrenia which was not statistically significant. In multivariate fixed-effects models (Table 4), we found that PCMH enrollment was generally associated with an

Table 2: Descriptive Statistics

Variable	N (%) or Mean (SD)			t-Test or Chi-Square p-Value
	Full Sample	Nonmedical Home	Medical Home	
N(person-years)	208,122	62,977 (30.3%)	145,145 (69.7%)	
Male	67,423 (32.4%)	23,614 (37.5%)	43,809 (30.2%)	<.001
Age	43.91 (12.066)	44.82 (12.10)	43.52 (12.03)	<.001
Race				
White	104,058 (50.0%)	33,829 (53.7%)	70,229 (48.4%)	<.001
Black	89,300 (42.9%)	24,582 (39.0%)	64,718 (44.6%)	
Asian	1,107 (0.5%)	406 (0.6%)	701 (0.5%)	
American Indian	4,220 (2.0%)	1,185 (1.9%)	3,035 (2.1%)	
Pacific Islander	131 (0.1%)	32 (0.1%)	99 (0.1%)	
Other	9,306 (4.5%)	2,943 (4.7%)	6,363 (4.4%)	
Hispanic Ethnicity	4,857 (2.3%)	1,667 (2.6%)	3,190 (2.2%)	<.001
Total #	10.97 (5.26)	10.17 (5.58)	11.32 (5.08)	<.001
Comorbidities				
Medicaid-enrolled months	10.39 (2.93)	9.11 (3.82)	10.94 (2.22)	<.001
Prevalence of specific comorbidities (overlapping)				
Diabetes	7,0481 (33.9%)	2,1524 (34.2%)	48,957 (33.7%)	.047
Hypertension	116,448 (56.0%)	35,432 (56.3%)	81,016 (55.8%)	.061
Hyperlipidemia	49,130 (23.6%)	15,405 (24.5%)	33,725 (23.2%)	<.001
Asthma	32,273 (15.5%)	9,151 (14.5%)	23,122 (15.9%)	<.001
Major depression	66,985 (32.2%)	19,439 (30.9%)	47,546 (32.8%)	<.001
Schizophrenia	19,867 (9.5%)	6,550 (10.4%)	13,317 (9.2%)	<.001
COPD	22,062 (10.6%)	7,180 (11.4%)	14,882 (10.3%)	<.001
Seizure disorder	11,410 (5.5%)	3,855 (6.1%)	7,555 (5.2%)	<.001

increase in the likelihood of receiving guideline-concordant care for chronic physical conditions. Among patients with diabetes, PCMH enrollment increased the probability of receiving hemoglobin A1C testing by 9.65 percentage points ($p < .001$), a proportional increase of 15.69 percent above the mean from observed controls. Attention for nephropathy increased by 5.18 percentage points, a 17.10 percent proportional increase, and eye examinations increased by 8.87 percentage points (all $p < .001$), a 29.57 percent proportional increase. Liver function tests increased by 1.81 percentage points ($p = .026$), a proportional increase of 8.74 percent. For the subgroup of patients with either diabetes or hyperlipidemia, PCMH enrollment was associated with a 12.50 percentage point increase in the likelihood of receiving a

Table 3: Unadjusted Rates of Service Use

<i>Quality Measures</i>	<i>Unadjusted Mean (%)</i>		<i>Chi-Square p-Value</i>
	<i>Nonmedical Home</i>	<i>Medical Home</i>	
Diabetes			
A1C	61.50	82.10	<.001
Attention for nephropathy	30.30	43.50	<.001
Liver function	20.70	25.40	<.001
Eye examination	30.00	44.20	<.001
Diabetes or hyperlipidemia			
Lipids panel	51.00	70.72	<.001
Diabetes and hypertension			
ACE/ARB	53.30	78.60	<.001
Asthma			
SABA overuse	7.80	10.40	<.001
Major depression			
Psychotherapy	38.00	45.80	<.001
Schizophrenia			
Psychotherapy	41.30	44.60	<.001
ACT	12.50	13.30	.118

lipid profile ($p < .001$), a relative increase of 24.53 percent above observed controls. Among patients with both diabetes and hypertension, PCMH enrollment increased the probability of receiving an ACE/ARB by 14.80 percentage points ($p < .001$), a 27.79 percent relative increase. However, non-PCMH enrollees were less likely to overuse certain medical therapies for asthma; PCMH enrollment increased the probability of SABA overuse by 2.62 percentage points ($p < .001$), a 33.59 percent proportional increase above nonenrollees.

Patient-centered medical home enrollees were also more likely to receive recommended services for mental health conditions. Enrollment in a PCMH was associated with a 4.36 percentage point increase in the probability of receiving any psychotherapy among patients with major depression ($p < .001$), an 11.47 percent proportional increase. Among patients with schizophrenia, being enrolled in a PCMH was associated with a 3.10 percentage point increase in the likelihood of receiving psychotherapy ($p = .018$) and a 1.64 percentage point increase in ACT visits ($p = .025$), 7.51 percent and 13.12 percent proportional increases, respectively.

Sensitivity analyses excluding 12-month PCMH enrollees produced effect sizes similar to those from the primary models, suggesting that these results were not driven primarily by continuous PCMH enrollees (results

Table 4: Average Differences in Disease-Specific Quality-of-Care Measures

Quality Measure	Effect of Medical Home Enrollment		Delta Method Standard Error
	Percentage Point Increase	Proportional Increase (%)	
Diabetes			
A1C	9.65**	15.69	0.695
Attention for nephropathy	5.18**	17.10	0.930
Liver function test	1.81*	8.74	0.815
Eye examination	8.87**	29.57	0.979
Diabetes or hyperlipidemia			
Lipids panel	12.51**	24.53	0.18
Diabetes and hypertension			
ACE/ARB	14.81**	27.79	0.879
Asthma			
SABA overuse	2.62**	33.59	0.956
Major depression			
Psychotherapy	4.36**	11.47	0.892
Schizophrenia			
Psychotherapy	3.10*	7.51	1.310
ACT visits	1.64*	13.12	0.733

** $p < .01$, * $p < .05$.

available from the corresponding author upon request). The same was true for analyses that limited the sample to beneficiaries with 12 continuous months of Medicaid enrollment; in these models, we saw effects similar in direction to those observed in the primary analysis and slightly smaller in magnitude.

DISCUSSION

Overall, quality-of-care metrics for both mental and physical health conditions generally improved among patients enrolled in a PCMH. PCMH enrollees with diabetes and/or hypertension experienced the largest proportional improvements (in receipt of eye examinations, lipid panels, and ACE/ARB) compared to nonenrolled controls. The effects were large enough to indicate a substantial change in practice patterns, even after controlling for baseline differences between PCMH enrollees and nonenrollees. These findings provide support for the idea that PCMHs can improve quality-of-care metrics for patients with MCC. Notably, SABA overuse among beneficiaries with asthma was an exception to the trend of improved quality metrics; PCMH enrollees

with asthma demonstrated an increase in SABA overuse compared to those not in PCMHs. However, this metric captures only medication dispensing and not actual use and therefore may reflect a greater propensity to have adequate (or even excess) inhalers available. This result may be due to the increased patient–physician contact that occurs in PCMHs (Lichstein et al. 2014; Chu et al. 2016).

Few previous studies have explicitly examined the effect of the PCMH model on process quality measure performance for chronic illness (Williams et al. 2012). Several studies have examined interventions that incorporate elements of the PCMH model such as care coordination or patient-centered care without using the designation of “medical home” or “PCMH”. To put the magnitude of these findings into context, we compared these results to other studies using claims data to assess the impact of care coordination on quality of care. Prior literature yielded mixed results; a systematic review and meta-analysis of 15 randomized trials assessing the effects of care coordination interventions on quality of care for Medicare beneficiaries reported only scattered significant effects for claims-based disease-specific quality measures for diabetes, including increases in A1C testing (approximately 5 percentage points), lipids panels (between 6 and 7 percentage points), and eye examinations (approximately 7 percentage points; Peikes et al. 2009). Compared to these previous findings, we observed larger and more consistent effects, which may be due to the comprehensive nature of the PCMH model.

We found significant differences in baseline characteristics between CCNC enrollees and their non-PCMH counterparts. These differences are likely due to beneficiary self-selection into the program. Particular groups of beneficiaries are not targeted for enrollment; almost all North Carolina Medicaid beneficiaries are given the option to enroll in a PCMH. However, participation in the program is voluntary and patient characteristics influence the decision to enroll. For example, on average PCMH enrollees had one more comorbid condition than nonenrollees, which may be because beneficiaries with more comorbidities opted for the PCMH program, which has higher levels of care coordination. Despite this, for six of the eight target conditions examined here—asthma and depression being the exceptions—beneficiaries not enrolled in a PCMH were more likely to have a diagnosis. Finally, the implications of the quality results for total costs of care are not examined here but would be important in determining the cost-effectiveness of the PCMH model.

This study has several limitations. First, our sample is limited to North Carolina Medicaid beneficiaries and the results of this analysis

may not generalize to other populations. In particular, our study population consists of traditional Medicaid enrollees in a nonexpansion state. However, these results may also have implications for the Medicaid-funded health home model promoted in the ACA, which has similarities to the PCMH. Second, we defined PCMH participation as any enrollment in a year, which may not capture the effects of extended duration of PCMH contact. However, our definition likely produces a conservative estimate of the association between PCMH enrollment and quality metrics. In related work using the same project data, we found that greater duration of PCMH enrollment was associated with an increased likelihood of receiving guideline-concordant depression care for patients with MCC (Swietek et al. 2018). We found a 1.7 percentage point increase in the likelihood of receiving guideline-concordant care at 4 months of PCMH enrollment, as compared to a single month of enrollment ($p = .018$). This effect increased with each additional month of PCMH enrollment; 12 months of enrollment was associated with a 19.1 percentage point increase in the likelihood of receiving guideline-concordant care over a single month of enrollment. Aggregation to the annual basis also means that the timing of PCMH enrollment may be confounded with outcomes for partial-year enrollees and does not allow us to tease out the timing of PCMH enrollment from the reported quality measures (i.e., utilization could occur during months not enrolled in a PCMH for partial-year enrollees). Additionally, while fixed-effects analyses supported the causal interpretation of our estimates by controlling for time-invariant factors that affect the outcomes, we were not able to control for unobserved time-variant factors that may differentially affect PCMH enrollment. For example, beneficiaries may enroll in a PCMH when they are symptomatic or when the severity of their condition worsens, which we are not able to measure in claims data.

Despite these limitations, our results suggest that the PCMH model has broad benefits for improving quality of care in patients with MCC. While prior studies indicate potential for the PCMH model to improve care processes for chronic care, previous results have been mixed with heterogeneity in statistical significance and modest effect sizes (Peikes et al. 2009; Williams et al. 2012). Both the statistical significance and magnitude of our findings suggest that the PCMH model is an effective way to improve chronic illness care in a nonelderly Medicaid population with multiple chronic conditions.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: This work was funded by the Agency for Healthcare Research and Quality (Grant No. R24 HS019659-01). Dr. DuBard and Dr. Jackson were employed by Community Care of North Carolina (CCNC) during the conduct of this research. CCNC operates the medical home program that is the subject of this analysis. The authors report no other relevant financial interests pertaining to this manuscript.

Disclosures: None.

Disclaimer: None.

REFERENCES

- Akinci, F., and P. M. Patel. 2014. "Quality Improvement in Healthcare Delivery Utilizing the Patient-Centered Medical Home Model." *Hospital Topics* 92 (4): 96–104.
- Anand, K., and M. Parekh. 2014. "Optimizing Health for Persons with Multiple Chronic Conditions." *Journal of the American Medical Association* 312 (12): 1–2.
- Anderson, G. 2010. "Chronic Care: Making the Case for Ongoing Care" Princeton, NJ [accessed on January 5, 2018]. Available at www.rwjf.org/pr/product.jsp?id=50968
- Arauz-Pacheco, C., M. A. Parrott, and P. Raskin. 2004. "American Diabetes Association. Hypertension Management in Adults with Diabetes." *Diabetes Care* 27 (Suppl 1): S65–7.
- Beadles, C. A., J. F. Farley, A. R. Ellis, J. C. Lichstein, J. P. Morrissey, C. A. DuBard, and M. E. Domino. 2015. "Do Medical Homes Increase Medication Adherence for Persons with Multiple Chronic Conditions?" *Medical Care* 53 (2): 168–76.
- Boult, C., L. Reider, K. Frey, B. Leff, C. M. Boyd, J. L. Wolff, S. Wegener, J. Marsteller, L. Karm, and D. Scharfstein. 2008. "Early Effects of "Guided Care" on the Quality of Health Care for Multimorbid Older Persons: A Cluster-Randomized Controlled Trial." *Journal of Gerontology* 63A (3): 321–7.
- Boyd, C. M., L. Reider, K. Frey, D. Scharfstein, B. Leff, J. Wolf, C. Groves, L. Karm, S. Wegener, J. Marsteller, and C. Boult. 2010. "The Effects of Guided Care on the Perceived Quality of Health Care for Multi-Morbid Older Persons: 18-Month Outcomes from a Cluster-Randomized Controlled Trial." *Journal of General Internal Medicine* 25 (3): 235–42.
- Chu, L.-H., M. Tu, Y.-C. Lee, and N. Sood. 2016. "The Impact of Patient-Centered Medical Homes on Safety Net Clinics." *American Journal of Managed Care* 22 (87): 532–8.
- Dixon, L. B., F. Dickerson, A. S. Bellack, M. Bennett, D. Dickinson, R. W. Goldberg, A. Lehman, W. N. Tenhula, C. Calmes, R. M. Pasillas, J. Peer, and J. Kreyenbuhl. 2010. "The 2009 Schizophrenia PORT Psychosocial Treatment Recommendations and Summary Statements." *Schizophrenia Bulletin* 36 (1): 48–70.

- Dobson, L. A., and D. L. Hewson. 2009. "Community Care of North Carolina—An Enhanced Medical Home Model." *North Carolina Medical Journal* 70 (3): 219–24.
- Domino, M. E., C. A. Beadles, J. C. Lichstein, J. F. Farley, J. P. Morrissey, A. R. Ellis and C. A. DuBard. 2014. "Heterogeneity in the Quality of Care for Patients with Multiple Chronic Conditions by Psychiatric Comorbidity." *Medical Care* 52 (suppl 3): S101–9.
- Dubard, C. A. 2013. "North Carolina Integrated Data for Researchers (NCIDR): Merged Behavioral Health Data from Four Publicly-Funded Sources in North Carolina, July 2007–June 2011." *ICPSR Data Holdings*. <https://doi.org/10.3886/ICPSR34542.v1>
- Fillmore, H., C. A. DuBard, G. A. Ritter, and C. T. Jackson. 2014. "Health Care Savings with the Patient-Centered Medical Home: Community Care of North Carolina's Experience." *Population Health Management* 17 (3): 141–8.
- Gelenberg, A. J., M. P. Freeman, J. C. Markowitz, J. F. Rosenbaum, M. E. Thase, M. H. Trivedi, and R. S. Van Rhoads. 2010. "Practice Guideline for the Treatment of Patients with Major Depressive Disorder: Third Edition" [accessed on April 27, 2015]. Available at http://psychiatryonline.org/pb/assets/raw/sitewide/practice_guidelines/guidelines/mdd.pdf
- Gerteis, J., D. Izrael, D. Deitz, L. LeRoy, R. Ricciardi, T. Miller, and J. Basu. 2014. "Multiple Chronic Conditions Chartbook 2010 Medical Expenditure Panel Survey Data" Rockville, MD [accessed on November 10, 2017]. Available at <https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/prevention-chronic-care/decision/mcc/mccchartbook.pdf>
- Grembowski, D., J. Schaefer, K. Johnson, H. Fischer, S. L. Moore, and M. Tai-Seale. 2014. "A Conceptual Model of the Role of Complexity in the Care of Patients with Multiple Chronic Conditions." *Medical Care* 52: S7–14.
- Jackson, G. L., B. J. Powers, R. Chatterjee, J. P. Bettger, A. R. Kemper, V. Hasselblad, R. J. Dolor, R. J. Irvine, B. L. Heidenfelder, A. S. Kendrick, R. Gray, and J. W. Williams. 2013. "Improving Patient Care. The Patient Centered Medical Home. A Systematic Review." *Annals of Internal Medicine* 158 (3): 169–78.
- Lehman, A. F., J. A. Lieberman, L. B. Dixon, T. H. McGlashan, A. L. Miller, D. O. Perkins, and J. Kreyenbuhl. 2004. "Practice Guideline for the Treatment of Patients with Schizophrenia, Second Edition. Work Group on Schizophrenia" [accessed on October 10, 2017]. Available at http://psychiatryonline.org/pb/assets/raw/sitewide/practice_guidelines/guidelines/schizophrenia.pdf
- Lichstein, J. C., M. E. Domino, C. A. Beadles, A. R. Ellis, J. F. Farley, J. P. Morrissey, G. W. Gauchat, C. A. Dubard, and C. T. Jackson. 2014. "Use of Medical Homes by Patients with Comorbid Physical and Severe Mental Illness." *Medical Care* 52 (suppl 3): S85–91.
- Maciejewski, M. L., and E. A. Bayliss. 2014. "Approaches to Comparative Effectiveness Research in Multimorbid Populations." *Medical Care* 52: S23–30.
- McCarthy, D., and K. Mueller. 2010. "Community Care of North Carolina: Building Community Systems of Care through State and Local Partnerships." *Commonwealth Fund* 20 (6): 501–8.

- McKenney, J. M., M. H. Davidson, T. A. Jacobson, and J. R. Guyton. 2006. "National Lipid Association Statin Safety Assessment Task Force. Final Conclusions and Recommendations of the National Lipid Association Statin Safety Assessment Task Force." *American Journal of Cardiology* 97 (8): S89–94.
- National Quality Measures Clearinghouse. 2014. *Comprehensive Adult Diabetes Care: Percentage of Patients 18 to 75 Years of Age with Type 1 or Type 2 Diabetes Who Had an Eye Exam (Retinal) Performed*. Rockville MD: Agency for Healthcare Research and Quality (AHRQ).
- National Quality Measures Clearinghouse. 2015a. *Comprehensive Diabetes Care: Percentage of Members 18 to 75 Years of Age with Diabetes (Type 1 and Type 2) Who Had Hemoglobin A1c (HbA1c) Testing*. Rockville MD: Agency for Healthcare Research and Quality (AHRQ).
- National Quality Measures Clearinghouse. 2015b. *Comprehensive Diabetes Care: Percentage of Members 18 to 75 Years of Age with Diabetes (Type 1 and Type 2) Who Received Medical Attention for Nephropathy*. Rockville MD: Agency for Healthcare Research and Quality (AHRQ).
- NC Department of Health and Human Services. 2018. "Assertive Community Treatment (ACT)" [accessed on February 26, 2018]. Available at <https://www.ncdhhs.gov/divisions/mhddas/adultmentalhealth/act>
- Parekh, A., and M. Barton. 2010. "The Challenge of Multiple Comorbidity for the US Health Care System." *Journal of the American Medical Association* 303 (13): 1303–4.
- Peikes, D., A. Chen, J. Schore, and R. Brown. 2009. "Effects of Care Coordination on Hospitalization, Quality of Care, and Health Care Expenditures among Medicare Beneficiaries." *Journal of the American Medical Association* 301 (6): 603.
- Priest, J. L., C. R. Cantrell, J. Fincham, C. L. Cook, and S. P. Burch. 2011. "Quality of Care Associated with Common Chronic Diseases in a 9-State Medicaid Population Utilizing Claims Data: An Evaluation of Medication and Health Care Use and Costs." *Population Health Management* 14 (1): 43–54.
- Swietek, K. E., M. E. Domino, C. A. Beadles, A. R. Ellis, C. Farley, J. F. Grove, L. R. C. Jackson, and C. A. DuBard. 2018. *Duration of Medical Home Enrollment & Quality of Depression Care for Patients with Multiple Chronic Conditions*. Working Paper.
- Vogeli, C., A. E. Shields, T. A. Lee, T. B. Gibson, W. D. Marder, K. B. Weiss, and D. Blumenthal. 2007. "Multiple Chronic Conditions: Prevalence, Health Consequences, and Implications for Quality, Care Management, and Costs." *Journal of General Internal Medicine* 22 (Suppl 3): 391–5.
- Wagner, E. H. 2001. "Meeting the Needs of Chronically Ill People." *British Medical Journal* 323 (7319): 945–6.
- Williams, J. W., G. L. Jackson, B. J. Powers, R. Chatterjee, J. P. Bettger, A. R. Kemper, V. Hasselblad, R. J. Dolor, R. J. Irvine, B. L. Heidenfelder, A. S. Kendrick, and R. Gray. 2012. Closing the Quality Gap: Revisiting the State of the Science (Vol. 2: The Patient-Centered Medical Home). *Evidence Report/Technology Assessment* 208 (2): 1–210.
- Willson, C. F. 2009. "Building Primary Care Medical Homes within the Community Care of North Carolina Program." *North Carolina Medical Journal* 70 (3): 231–6.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix SA1: Author Matrix.