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RESEARCH ARTICLE

The Reduction in ED and Hospital Admissions in Medical Home Practices Is Specific to Primary Care–Sensitive Chronic Conditions

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Objective. To determine whether the Patient-Centered Medical Home (PCMH) transformation reduces hospital and ED utilization, and whether the effect is specific to chronic conditions targeted for management by the PCMH in our setting.

Data Sources and Study Setting. All patients aged 18 years and older in 2,218 primary care practices participating in a statewide PCMH incentive program sponsored by Blue Cross Blue Shield of Michigan (BCBSM) in 2009–2012.

Study Design. Quantitative observational study, jointly modeling PCMH-targeted versus other hospital admissions and ED visits on PCMH score, patient, and practice characteristics in a hierarchical multivariate model using the generalized gamma distribution.

Data Collection. Claims data and PCMH scores held by BCBSM.

Principal Findings. Both hospital and ED utilization were reduced proportionately to PCMH score. Hospital utilization was reduced by 13.9 percent for PCMH-targeted conditions versus only 3.8 percent for other conditions ($p = .003$), and ED utilization by 11.2 percent versus 3.7 percent ($p = .010$). Hospital PMPM cost was reduced by 17.2 percent for PCMH-targeted conditions versus only 3.1 percent for other conditions ($p < .001$), and ED PMPM cost by 9.4 percent versus 3.6 percent ($p < .001$).

Conclusions. PCMH transformation reduces hospital and ED use, and the majority of the effect is specific to PCMH-targeted conditions.

Key Words. Medical home, care, patient-centered, primary care, health services, cost, quality

BACKGROUND

The Patient-Centered Medical Home (PCMH) model of primary care has been developed and disseminated over the last two decades with the goal of making primary care "patient-centered, comprehensive, team-based,

coordinated, accessible, and focused on quality and safety" (Patient-Centered Primary Care Collaborative 2014). It has been widely adopted by integrated delivery systems, financial incentives for independent practices to adopt it have been implemented by many payers, Medicare has launched a major demonstration program to evaluate it (Centers for Medicare & Medicaid Innovation 2014), and both a national measurement and recognition system (National Commission on Quality Assurance 2014) and payer-specific measurement systems (Alexander et al. 2013) have been developed.

However, whether and by how much the PCMH model improves quality and reduces cost of care, particularly outside of the confines of centrally managed integrated health systems, remains unclear. Reviews have found mixed evidence (Hoff, Weller, and DePuccio 2012; Peikes et al. 2012; Jackson et al. 2013; Higgins et al. 2014), and recent studies have been relatively small (Fifield et al. 2013; Liss et al. 2013; Rosenthal et al. 2013; Werner et al. 2013; Cole et al. 2015; Friedberg et al. 2015) or limited to integrated delivery systems (Gilfillan et al. 2010; Reid et al. 2010, 2013; Maeng et al. 2015). One recent moderate-sized multipayer evaluation of NCQA-certified PCMH implementation found only limited quality improvements and no improvement in cost of care, hospitalizations, or emergency department (ED) utilization (Friedberg et al. 2014), while conversely a somewhat larger study found improvements in quality and decreases in cost and utilization only for ED visits plus a small effect on inpatient admissions limited to patients with two or more comorbidities (Rosenthal et al. 2015), and a recent small study of safety-net clinics also found mixed results (Cole et al. 2015).

We have previously reported improvements in both quality measures and cost of care from the largest state-level PCMH implementation program in the United States, but these evaluations did not detail the areas of utilization impacted (Paustian et al. 2014; Alexander et al. 2015). This large program was not a randomized controlled trial, the gold standard for assessing causality. The plausibility of a causal inference, that is, that the PCMH transformation was responsible for the observed improvement, rather than a general

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effect of better-managed practices achieving both better PCMH scores and quality and cost measures, would be enhanced by demonstrating specificity of effect in addition to the dose–response relationship (improvement proportional to degree of PCMH transformation achieved) that we previously reported. Therefore, we sought to determine whether PCMH implementation was associated with reductions in hospitalizations and ED utilization and whether this effect was specific to conditions targeted for team-based chronic disease management in the PCMH model.

As this manuscript was in draft, David et al. published a demonstration of specificity of effect in Pennsylvania (David et al. 2015). The present work reports similar findings in a different state and adds to the literature by having a much larger (over eight times) and more diverse (statewide not limited to a metropolitan area and including rural practices) sample, and using continuous (rather than binary) PCMH scores that have been verified (vs. only self-reported).

METHODS

This project was reviewed by the University of Michigan IRBMED. It received a not-regulated determination (HUM00039802) as it is research on organizations, not human subjects research.

Study Population

This study focused on 2,218 nonpediatric primary care practices that participated in Blue Cross Blue Shield of Michigan's (BCBSM's) Physician Group Incentive Program (PGIP) for at least two consecutive years between June 2009 and June 2012, for a total of 5,452 observed practice-years. Practices were excluded from the analysis if specialists accounted for the majority of physicians in the practice ($n = 41$). We also excluded pediatric practices, defined as practices with at least 80 percent of members below 18 years ($n = 329$) because of our focus on outcomes for adult patients. Practices with missing data were also excluded ($n = 127$). No minimum panel size was required for participation.

Data Sources

Physician organizations participating in the PGIP reported information about their affiliated practices, including the practice's physician composition and

the PCMH capabilities implemented by the practice, to BCBSM every 6 months. We focused on capabilities reported in June of each year, which were not used to determine incentives for BCBSM's PCMH designation program. To assess other over-reporting that might be encouraged through the PGIP incentive program, BCBSM conducted site visits for a selection (roughly 10 percent) of these practices. In 2012, 95 percent of self-reported capabilities were confirmed to be actively used at the 323 primary care practices randomly selected for site visits (Paustian 2013).

We used BCBSM member enrollment information to obtain demographic data, such as age, gender, and zip code, on members who received care at these practices and administrative claims data to identify health care utilization of members. The practice's patient panel of BCBSM members was identified using an algorithm that attributed members to a single primary care provider using the members' administrative claims from the previous 24 months.

In addition, we used zip code-level data from the 2010 U.S. Census and the 2011 American Community Survey to address potential confounding by practice environment characteristics.

Measures

PCMH Implementation Score. Using their PCMH capability data, we calculated each practice's PCMH implementation scores for each of the four June reporting periods using our previously published method (Alexander et al. 2013). Detailing that method is beyond our scope here, but briefly it comprises a total of 128 capabilities across 13 domains (Table 1). Each domain is scored as a percentage of the capabilities present, and the total score is the mean of the domain scores. A PCMH score of "1" reflects full implementation of the PCMH model, while a score of "0" reflects no implementation of the PCMH model. Specifics of how each capability is scored are presented in the previous publication. While there are significant similarities between the NCQA PCMH program and the BCBSM PCMH program (Burton, Devers, and Berenson 2012), the BCBSM scoring method reflects that there are no "must pass" requirements and the program's intended goal of capturing each incremental improvement.

For each of the study years examined (July 2009–June 2010, July 2010–June 2011, and July 2011–June 2012), we recorded level of PCMH implementation using the PCMH capability scores reported in the preceding June. We

Table 1: Overview of PCMH Score Components

Domain	*Description*	*No. of Capabilities*
Patient–provider partnership	Practice has developed and is using PCMH-related communication tools	8
Patient registry	An all-payer registry is used to manage established patients in the practice	18
Performance reporting	Performance reports are generated that allow tracking and comparison of results for the established population of patients in the practice	13
Individual care management	Practice has ability to deliver coordinated care management services with an integrated team of multidisciplinary providers and a systematic approach is in place to deliver comprehensive care that addresses patients' full range of health care needs	15
Extended access	Patients have 24-hour access to a clinical decision maker by phone, and clinical decision maker has a feedback loop within 24 hours or next business day to the patient's PCMH	9
Test results tracking & follow-up	Practice has test tracking process documented and in place which requires tracking and follow-up for all tests and results, with identified time frames for notifying patients of results	9
e-prescribing	Practice has adopted and uses electronic prescribing and clinical decision support tools to improve the safety, quality, and cost-effectiveness of the prescription process	2
Preventive services	Primary prevention program is in place that focuses on identifying and educating patients about personal health behaviors to reduce their risk of disease and injury	8
Linkage to community services	A comprehensive review of, and linkage to, community resources has been completed	8
Self-management support	A systematic approach to empowering the patient to understand their central role in effectively managing their illness, making informed decisions about care, and engaging in healthy behaviors is in place	8
Patient web portal	A patient web portal is in use by the practice to allow for electronic communication between patients and physicians, and provide greater access to medical information and technical tools	12
Coordination of care	For patients with selected chronic conditions, a mechanism is established for being notified of each patient admit and discharge or other type of encounter, and appropriate transition plans are in place	9
Specialist referral process	Procedures are in place to guide each phase of the specialist referral process	9

also recorded the change in PCMH implementation scores during the study year as the difference in scores between consecutive June reporting periods.

Outcomes. The outcomes of interest for this study were nonmaternity inpatient (IP) and emergency department (ED) visits. Visits were divided into those for the chronic diseases targeted for PCMH care management (diabetes, angina, asthma, chronic obstructive pulmonary disease, congestive heart failure, and hypertension) and for all other reasons.

PCMH-targeted conditions were identified using International Classification of Diseases, Ninth Revision (ICD-9) codes. Visit rates were calculated for each study year at the practice level, based on the practice's adult (ages 18–64) attributed BCBSM member patient panel. Rates were calculated per 1,000 members, weighted by the proportion of the study year that they were insured by BCBSM. We also calculated medical and surgical per-member per-month (PMPM) costs for these visits, standardized to be valued in 2010 dollars so that they could be compared over time.

Practice Characteristics. We controlled for six practice characteristics: (1) practice size; (2) primary care focus; (3) BCBSM patient volume; (4) number of years in the PGIP; (5) physician turnover; and (6) practice movement between physician organizations. Practice size was based on the total number of physicians in practice, including specialists. Practices with at least one specialist were classified as "multispecialty" as opposed to "primary care-only" practices. BCBSM patient volume was measured by proxy as the average number of BCBSM-paid services delivered per primary care provider (PCP) in the practice. The average number of years that a practice's PCPs participated in the PGIP was used as a measure of experience with the incentive program. Physician turnover, calculated as the proportion of a practice's physicians that left the practice over the course of each study year, and whether a practice changed physician organizations during the study year were used as measures of practice instability.

Patient Panel Characteristics. We included two patient characteristics, both estimated using the practice's adult BCBSM member patient panel: (1) the proportion of members who were female; and (2) the mean prospective risk score. The prospective risk score we adopted is one widely used in the U.S.

health care sector (Optum.com 2014). It is a commercially available product that employs a large national database of aggregated claims and membership information to derive a numerical, diagnosis-based episode assessment used to predict future medical costs. It has been extensively validated against that outcome in a wide range of settings.

Other Characteristics. We also controlled for six practice environment characteristics and one physician organization characteristic. Environment characteristics were based on the zip codes where the practice's treated patients resided, rather than the physical location of the practice. Each practice's score was the average of zip code characteristics where their patients resided, weighted based on the proportion of the practice's care provided to members residing in that zip code.

The 2010 U.S. Census was used to identify the percent of residents who were nonwhite or Hispanic and the percent of residents who lived in a rural area by zip code. Unemployment was also identified using the 2011 American Community Survey. To estimate the number of PCPs per 1,000 residents, we used the BCBSM Provider Enrollment and Credentialing System, which captures about 94 percent of active physicians in Michigan, and 2010 U.S. Census population estimates. We also estimated BCBSM market share using member subscriber addresses from BCBSM member enrollment information and 2010 U.S. Census population estimates. In addition, we measured the physician organization size as the total number of affiliated practices with at least one PCP.

Analytic Approach. Using the physician practice as the unit of analysis, we analyzed the relationship between level of PCMH implementation and IP/ED visit rates and cost, comparing whether there were differences in the association for PCMH-targeted conditions and all other visits. IP and ED visits were analyzed in separate models using the same modeling structure. For both IP and ED visit rates, visits for PCMH-targeted conditions and other visits were jointly modeled, a technique for allowing for simultaneous comparison between two different types of outcomes. A significant fraction of practices' PCMH-targeted condition IP and ED rates were zero, so these rates were measured in two steps (Liu et al. 2010). The first step used a binary probit model to model the propensity of having any visits for PCMH-targeted conditions. The second step modeled the magnitude of nonzero PCMH-targeted

condition rates using a generalized gamma (GGM) distribution (Manning, Basu, and Mullahy 2005). Because health care utilization data are frequently present with skewness and heterogeneity, we extended the GGM to allow for heteroscedastic errors (GGM-het), using the mean prospective risk score to account for the heteroscedasticity. Less than 1 percent of the other, non-PCMH-targeted condition visit rates were zero, so they were modeled with a GGM-het using a similar framework to the second step of the PCMH-targeted condition model. Models for cost used the same framework.

All models included a random effect for the practice-year to account for the correlation between the jointly modeled outcomes. In addition, we used time-varying random effects for the physician organization to model their cumulative contributions over the three study years while accounting for practice movement between physician organizations. Models also included fixed effects for level of PCMH implementation at the start of the study year and change in PCMH implementation that occurred during the study year, and adjusted for the study year and all of the practice, patient, and other covariates described above. Practice-years where practices had fewer than 50 adult members in their patient panel were excluded from the analysis ($n = 352$).

To help in interpreting the regression coefficients, we estimated the elasticity (Wooldridge 2010) of the relationship between level of PCMH implementation and visit rates and cost at the sample means of all of the explanatory variables. Elasticity is a unitless measure that can be used to characterize relationships in nonlinear models. Here, elasticity can be interpreted as the percent change in visit rates or cost for a 100 percent relative change in level of PCMH implementation. Standard errors and 95 percent confidence intervals for parameter estimates and elasticity were calculated using the resampling method. All analyses were conducted in *R* (The R Project for Statistical Computing 2014).

RESULTS

Table 2 displays the demographic, practice, and other characteristics of the sample. (Note that IP and ED utilization rates for targeted conditions may seem low because they are rates per total BCBSM membership, not only those diagnosed with the condition. Similarly, costs appear low because they are on a per-member-per-month basis, rather than annual cost for only diagnosed patients.)

Table 2: Characteristics of Study Practices, July 2009–June 2012

	Primary Care Practices (n = 5,452 practice-years)	
	Median	*IQR*
Outcomes		
ED visit rate per 1,000 members	205.8	159.9–276.4
ED visit rate for PCMH-targeted conditions per 1,000 members	3.9	0.0–8.4
IP visit rate per 1,000 members	75.7	57.5–105.3
IP visit rate for PCMH-targeted conditions per 1,000 members	2.0	0.0–6.1
ED visits PMPM cost	$19.9	$15.1–$26.9
ED visits for PCMH-targeted conditions PMPM cost	$0.3	$0.0–$0.8
IP visits PMPM cost	$110.5	$80.4–$158.1
IP visits for PCMH-targeted conditions PMPM cost	$1.6	$0.0–$5.6
Continuous variables		
PCMH score at beginning of study year	0.3	0.1–0.5
Change in PCMH score during study year	0.0	0.0–0.2
Number of physicians in practice	1	1–3
Panel size (adult BCBSM patients per practice)	327	161–729
Professional services per PCP in practice	1,486	839–2,441
Average number of years in PGIP for PCPs in practice	2.8	2.3–3.5
Turnover of physicians in practice during study year	0.0	0.0–0.0
Total practices in PO with a PCP	104	57–209
Percent BCBSM market share	31.9%	26.7–36.0%
Percent of residents who are nonwhite or Hispanic	18.3%	10.1–26.4%
Percent rural	17.9%	02.8–43.1%
Percent of residents who are unemployed	11.9%	10.1–13.9%
Number of PCPs per 1,000 residents	0.8	0.6–1.0
Percent of attributed members who are female	51.0%	46.0–57.8%
Mean prospective risk score (adult)	1.7	1.5–2.0
Categorical Variables	*N*	*%*
Study year	Practices	
Year 1: July 2009–June 2010	1,635	30.0
Year 2: July 2010–June 2011	1,842	33.8
Year 3: July 2011–June 2012	1,975	36.2
Practice specialty	Practice-years	
Primary care only	5,240	96.1
Multispecialty	212	3.9
Whether practice changed PO during time period		
No	4,993	91.6
Yes	459	8.4

BCBSM, Blue Cross Blue Shield of Michigan; ED, emergency department; IP, inpatient; IQR, interquartile range; PMPM, per member per month; PCMH, patient-centered medical home; PO, physician organization.

Table 3 presents the results of the modeling, for both outcomes, IP and ED. Both IP and ED utilization were inversely and proportionately related to PCMH score in this analysis. The effects of PCMH score for both outcomes differed substantially, in the hypothesized direction, for PCMH-targeted versus all other diagnoses. The elasticity estimates indicate that for a 100 percent increase in PCMH score from the sample mean of 0.34–0.68, inpatient admissions would be reduced by 13.9 percent for PCMH-targeted conditions versus only 3.8 percent for other conditions, for a difference of 10.1 percent ($p = .003$). Similarly, ED utilization would be reduced by 11.2 percent for PCMH-targeted conditions versus 3.7 percent for other conditions, for a difference of 7.5 percent ($p = .010$). The IP PMPM costs would be reduced by 17.2 percent for PCMH-targeted conditions versus 3.1 percent for other conditions, for a difference of 14.1 percent ($p < .001$). Similarly, ED PMPM costs would be reduced by 9.4 percent for

Table 3: Elasticity Estimates for ED and IP Rates and Cost, PCMH-Targeted versus All Other Conditions

	*Elasticity** (%)	*Lower CI* (%)	*Upper CI* (%)	*p-Value*
ED visit rate				
Effect of PCMH score on PCMH-targeted conditions	−11.2	−16.9	−3.8	<.001
Effect of PCMH score on all other conditions	−3.7	−5.8	−1.6	<.001
Difference in effect between PCMH-targeted and other conditions	−7.5	−13.5	−0.7	.010
IP visit rate				
Effect of PCMH score on PCMH-targeted conditions	−13.9	−20.8	−7.0	<.001
Effect of PCMH score on all other conditions	−3.8	−5.7	−1.7	<.001
Difference in effect between PCMH-targeted and other conditions	−10.1	−17.1	−3.0	.003
ED visit PMPM cost				
Effect of PCMH score on PCMH-targeted conditions	−9.4	−11.9	−7.3	<.001
Effect of PCMH score on all other conditions	−3.6	−4.1	−3.1	<.001
Difference in effect between PCMH-targeted and other conditions	−5.8	−8.3	−3.8	<.001
IP visit PMPM cost				
Effect of PCMH score on PCMH-targeted conditions	−17.2	−21.2	−13.3	<.001
Effect of PCMH score on all other conditions	−3.1	−4.2	−2.0	<.001
Difference in effect between PCMH-targeted and other conditions	−14.1	−18.4	−10.1	<.001

*Elasticity here is the percent change in visit rates or cost for a 100 percent change in level of PCMH implementation from the sample mean of 0.34–0.68.
CI, confidence interval; ED, emergency department; IP, inpatient; PCMH, patient-centered medical home; PMPM, per member per month.

Table 4: Absolute Change Estimates for ED and IP Utilization and Cost, PCMH-Targeted versus All Other Conditions

	*Estimate**	*Lower CI*	*Upper CI*
ED visit reduction per 1,000 members			
Effect of PCMH score on PCMH-targeted conditions	−0.74	−1.1	−0.25
Effect of PCMH score on all other conditions	−8.2	−12.8	−3.5
IP visit reduction per 1,000 members			
Effect of PCMH score on PCMH-targeted conditions	−0.74	−1.1	−0.37
Effect of PCMH score on all other conditions	−3.2	−4.8	−1.4
ED Visit PMPM cost savings ($)			
Effect of PCMH score on PCMH-targeted conditions	−0.07	−0.08	−0.05
Effect of PCMH score on all other conditions	−0.77	−0.87	−0.66
IP visit PMPM cost savings ($)			
Effect of PCMH score on PCMH-targeted conditions	−0.96	−1.2	−0.74
Effect of PCMH score on all other conditions	−3.9	−5.3	−2.5

*Estimates represent the difference in visit rates or cost for a 100 percent change in level of PCMH implementation from the sample mean of 0.34–0.68.
CI, confidence interval; ED, emergency department; IP, inpatient; PCMH, patient-centered medical home; PMPM, per member per month.

PCMH-targeted conditions versus 3.6 percent for other conditions, for a difference of 5.8 percent ($p < .001$).

To place these percent differences into absolute terms, Table 4 presents estimates of the absolute reduction in inpatient and ED utilization and costs corresponding to Table 3. (Note that the absolute number differences for nontargeted conditions are larger, although the percent changes much smaller, because of the very much larger denominator for nontargeted-condition ED and hospital utilization.)

There is a difference by practice size, with larger practices achieving a greater reduction in IP and ED utilization than smaller ones. The difference is small, however. The elasticity for practices at the third quartile of size was only 1.5 percent (absolute) greater than for those at the first percentile for IP, and 4.2 percent for ED.

DISCUSSION

Although we found a relationship between PCMH score and reductions in overall IP and ED visits, the effects were far higher for PCMH-targeted conditions. This specificity supports the hypothesis that it is the PCMH chronic

disease management activities that reduce cost and utilization, rather than a general effect of better-managed practices both achieving higher PCMH scores and having lower ED and IP utilization rates. PCMH score was associated with reduced IP and ED visits for conditions not specifically targeted for team-based care management, to a lesser extent. That is likely because components of the PCMH that do not target specific conditions (e.g., extended hours [O'Malley 2013]) provide benefit as well.

There are some important differences between the setting in which these results were achieved and those of projects discussed in the Background. First, this was a very large sample of practices, as much as two orders of magnitude larger than other recent studies. Further, the practices in this project were not part of a centrally managed or integrated delivery system, but rather a diverse mix of practices associated tightly or loosely with several competing integrated delivery systems and large numbers of independent private practices of widely varying size, structure, demographics, and location. The sample spanned 82 of Michigan's 83 counties, from urban to very rural, and included over half the primary care practices in the state, so it is not an exclusive or atypical set of practices. These factors argue strongly for the generalizability of our findings.

Other differences may be important both in interpreting our results in light of other literature and to leaders and policy makers seeking to replicate the PGIP program's success. The practices were not constrained to implement the PCMH functions in a specific manner or order, but rather implemented incrementally in a manner feasible for their individual contexts. The PGIP program supported learning collaboratives, directed by the practices themselves, to assist with change management. After-hours access to primary care services was one of the PCMH domain criteria on which incentives were conditioned, and evening and weekend access became the norm in most practices (Alexander et al. 2013).

It is worth noting that a much smaller study in Rhode Island (Rosenthal et al. 2013) did find a small reduction in ED visits for ambulatory care-sensitive conditions (Agency for Healthcare Research and Quality 2001) (ACSCs) among PCMH practices, although they did not find statistically significant differences otherwise. As noted in the Background, another small study, in Colorado, found reduced inpatient admissions (but *not* ED visits) among patients with two or more comorbidities (Rosenthal et al. 2015). We chose deliberately not to use all ACSCs in this study, but to focus on conditions specifically targeted by PCMH team-based chronic disease management. (Because this project was a mixed-methods study that included

qualitative data collection in over 50 practices, we were aware before we conducted our analysis of which conditions most practices were targeting for chronic disease management.) The ACSCs include a number of conditions sensitive to overall access to ambulatory care, but not particularly relevant to the goals of the PCMH, and hence would have made a less-than-ideal test of the specificity of effect we were seeking. We believe that our focus on PCMH-targeted conditions rather than ACSCs accounts for the more robust pattern of effects we demonstrated.

The context of the PGIP program also contributed a limitation to this study in providing incentives to reduce ED utilization. During the study time period, PGIP administered initiatives to reduce IP and ED visits among the practice's participating physician organizations. These included supporting learning collaboratives led by Lean coaches and similar logistical supports. There was also a small incentive for practices to reduce ED utilization, in that ED utilization scores for nonemergent, emergent but primary care–treatable, and emergent needing ED care but preventable or avoidable conditions using the NYU algorithm (Ballard et al. 2010) accounted for 4–5 percent of the score used to determine designation status in the BCBSM PCMH Designation Program (Emeott et al. 2013). Although no incentives specifically targeted the PCMH-sensitive conditions used in this study, it is possible that practices motivated to implement PCMH capabilities may also have been motivated to reduce ED utilization. It is important to note that the initiatives and incentives applied to all practices in our sample, and to all admissions not merely those targeted by the PCMH. Therefore, they may have "raised the floor," that is, helped practices in general achieve a higher baseline effect. However, they would not affect our study hypothesis, in that they would not have a differential effect by condition.

A key difference in our data is that early in the project, PCMH scores were validated by direct observation. Practices were given feedback that helped them become more accurate in their subsequent self-report scoring. In other settings, NCQA PCMH scores may represent "box-ticking" rather than actual transformational change in practices (Alexander and Bae 2012). Increased PCMH scores that do not represent actual practice change would not be expected to yield improved outcomes.

The important limitation of our study is that it is a prospective cohort, not a randomized trial. Although we controlled for a wide range of patient, practice, and geographic variables in our analyses, the possibility of unmeasured confounders remains. The dose–response relationship we previously documented (Paustian et al. 2014; Alexander et al. 2015) and the present

demonstration of specificity of effect weigh in favor of the conclusion that PCMH transformation is accomplishing its intended goals through the hypothesized mechanisms.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.