Do Patient-Centered Medical Homes Reduce Emergency Department Visits?

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Abstract

This paper assesses whether adoption of the Patient-Centered Medical Home (PCMH) reduces emergency department (ED) utilization among patients with and without chronic illness. We use administrative data from approximately 460,000 Independence Blue Cross patients enrolled in 280 primary care practices which converted to PCMH status from 2008-2012. We estimate the effect of a practice becoming PCMH certified on ED visits and costs for its patients using a difference-in-differences approach, employing either practice or patient fixed effects. We analyzed patients with and without chronic illness across six chronic illness categories. We find that among chronically ill patients, transition to PCMH status was associated with lower ED utilization. This finding was robust to a number of specifications, as well as to analyzing weekend ED visits alone. The largest reductions in ED visits are concentrated among chronic patients with diabetes and hypertension. Hence, the adoption of the PCMH model was associated with lower ED utilization for chronically ill patients, but not for those without chronic illness. The effectiveness of the PCMH model varies by chronic condition. Analysis of weekend ED visits suggests that reductions in ED utilization stem from better management of chronic illness rather than expanding access to primary care clinics.

Key Words: Patient-centered medical home, emergency department, chronic illness

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Following its endorsement in a 2007 “Joint Statement of Principles of the Patient-Centered Medical Home,” (American Academy of Family Physicians et al. 2007) the patient-centered medical home (PCMH) model and related innovations have shown early promise as a vehicle for reorganizing health care systems and improving the management of chronic illness. Studies of the medical home and related interventions have shown improvements in provider experience (Reid et al. 2010), patient experience (Reid et al. 2009; Reid et al. 2010; Solberg et al. 2011), processes of care (Zuckerman et al. 2004; Wise et al. 2006; Domino et al. 2009), practice-level composite measures of quality and preventive care utilization (Paustian et al. 2013) and economic outcomes such as total costs (Devries et al. 2012; Paustian et al. 2013) or high-intensity domains of care, such as hospital admissions or emergency department (ED) visits (Reid et al. 2010) for patients enrolled in primary care practices adopting the guidelines of the PCMH. Expectations that the PCMH will transform the delivery of care remain high.

However, systematic reviews of such evaluations of the PCMH demonstrate that the work to date is inconclusive and often yields conflicting results (Jackson et al. 2013; Peikes et al. 2012). For example, the transition to a PCMH model has been shown, variously, to reduce total costs (Devries et al. 2012) or increase costs (Domino et al. 2009; Peikes et al. 2009), while others found spending rose in some areas and fell in others (Reid et al. 2010) or found no significant effects (Leff et al. 2009). In discussing their results, most authors describing the impact of the PCMH emphasize the preliminary nature of their work, and call for further studies as data emerges from pilot projects. Additionally, several reviews of the PCMH literature point out methodological concerns regarding the existing work: studies examine too few practices, include inadequate follow-up and have failed to account for the clustering of results by practice (Peikes et al. 2011). Many early PCMH studies also lacked an appropriate comparison group, such as those relying on pre-post designs (Peikes et al. 2012). A recent study which made use of control practices and employed a difference-in-differences regression analysis found no significant differences in ED visits, admissions, readmissions or cost (Werner et al. 2013).

Outside of primary care, other medical professionals have raised concerns that excessive focus on the PCMH model might yield unintended negative consequences. In particular, hospital EDs constitute a “de facto safety net” for uninsured patients and an abrupt shift of resources away from such facilities might harm the most vulnerable patients (American College of Emergency Physicians Board of Directors 2008). Against this backdrop of scarce and contested resources and incomplete research, this paper intends to contribute to the growing literature evaluating the impact of adoption of the PCMH model by primary care practices. By using a novel identification strategy and a rigorous difference-in-differences approach to study a large administrative dataset - over one million patient-years across 280 PCMH-certified primary care practices - we aim to address the methodological concerns raised elsewhere, in order to sort through the uncertainty and point toward a research agenda for future evaluations of the PCMH model.

The Patient-Centered Medical Home

Parallel currents in the primary care literature highlight both the significant challenges the field faces, as well as primary care’s enormous potential when delivered effectively. There is widespread concern that the current fee-for-service reimbursement model will continue to produce greater volume rather than quality and underemphasizes the cognitively-intensive evaluation and management services on which primary care focuses (American College of Physicians 2006). Procedure-oriented reimbursement systems drive new doctors to better-compensated specialty fields, potentially creating a critical shortage of primary care doctors (Moore and Showstack 2003; Bodenheimer, Grumbach, and Berenson 2009). Moreover, the fragmentation of the health care system has led to an orientation better suited to addressing acute health crises rather than effectively managing chronic illness, leaving patients with ongoing health problems particularly vulnerable (Wagner, Austin, and Von Korff 1996; Bodenheimer, Wagner, and Grumbach 2002).

In light of these challenges, as well as the optimism surrounding initiatives to improve primary care, the PCMH model has garnered considerable interest in recent years. Though the concept of the “medical home” has been discussed since the 1960s (Sia et al. 2004), the modern PCMH model has gained new momentum following the publication of "Joint Statement of Principles of the Patient-Centered Medical Home." The medical home model calls for each patient to be assigned to a "personal physician," responsible both for maintaining an ongoing relationship with the patient directly, as well as directing a team of medical professionals within the primary care practice. The Joint Statement of Principles also calls for a "whole person orientation," caring for the patient through all stages of life, as well as providing preventive care, managing chronic illnesses and addressing acute medical issues as they arise.

Medical homes also address concerns about fragmentation in the health care system by using patient registries and other health information technology to track patient health and manage transitions across multiple settings of care. The PCMH model aims to enhance patient experience both through an explicit commitment to improving quality using evidence-based medicine and by facilitating patient and family involvement in care planning. Additionally, in order to improve access, the PCMH model stresses expanding practice hours for visits, as well as the use of electronic communication to address patient needs. The Joint Statement of Principles also acknowledged that in order to secure these practice-level improvements, the fee-for-service reimbursement system would have to be reformed to better compensate cognitive tasks in medicine, to pay providers for the value of expanded access to medical practices, to account for differences in patient risk profiles, and reward quality improvements (American Academy of Family Physicians et al. 2007).

The National Committee for Quality Assurance (NCQA) published guidelines for primary care practices looking to adopt the PCMH model in 2008 (updated in 2011) which largely reflect these principles. The NCQA also formally recognizes practices as having adopted these improvements using a three-level typology reflecting the number of reforms adopted. To gain recognition at each level, practices must demonstrate successful adoption of a group of "must pass" elements, and are graded using a point-based system for additional improvements (National Committee for Quality Assurance 2008). Though competing standards exist, the NCQA guidelines are the most widely used in the PCMH literature (Cassidy 2010; Friedberg et al.

2009). As of April 2013 there were 5,560 NCQA-certified PCMH practices in the United States (National Committee for Quality Assurance 2013).

The 2011 NCQA guidelines include 28 specific practice improvements across six categories, including enhanced access and continuity, identifying and managing patient populations, planning and managing care, providing self-care support and community resources, tracking and coordinating care, as well as measuring and improving performance (National Committee for Quality Assurance 2011). In terms of their impact on ED utilization, these categories can be grouped under two headings, divided by their hypothesized effect. Some improvements expand access to clinics (such expanded operating hours, electronic access, etc), potentially leading to substitution of primary care for expensive and intensive ED services; others are aimed at improving population health (like use of data for population management, identifying high risk patients, care coordination, use of electronic prescribing, and implementation of evidence-based guidelines. Disentangling the effects of these two categories of the PCMH has important implications for medical care and future policy.

Emergency Departments in Crisis

Primary care practices are not alone in facing serious challenges; hospital EDs in the US also struggle with staffing shortfalls, overcrowding and fragmentation of care systems. Demand for emergency care has been growing rapidly — the number of ED visits grew by 46.3 percent between 1991 and 2011. However, over the same period, the number of EDs declined by 647 from 5,108 to 4,461 (American Hospital Association 1991-2011). Frequently, overcrowding leads to ambulance diversions as patients are redirected from EDs at or above capacity. In 2003, ambulances were diverted 501,000 times—an average of once every minute (Institute of Medicine 2007). Periods of high ED crowding (as defined as elevated hospital-normalized rates of ambulance diversions) were associated with increased inpatient mortality and modest increases in length of stay and costs for admitted patients (Sun et al. 2013).

One potential driver of high ED volume is that patients with issues that could be addressed in a different, more appropriate setting (such as a physician's office or urgent care clinic) seek treatment in the ED instead. ED visits for such non-urgent health issues not only increase health care system spending, but also may lead to excessive or unnecessary treatment and testing. Though estimates vary, a substantial fraction of visits to EDs are for non-emergency care. One study calculated that between 13.7% and 27.1% of all ED encounters were for conditions that could have been addressed in retail or urgent care clinics, saving roughly $4.4 billion each year (Weinick, Burns, and Mehrotra 2010). Expanding access to primary care clinics may help address these problems, as patients reporting fewer barriers to after-hours contact with their physicians reported fewer ED visits (O'Malley 2013).

Conceptual models of the PCMH suggest that adoption of such reforms may lead to fewer ED visits by patients, both by improving the coordination of care and by reducing delays in treatment, thereby reducing the likelihood of complications (Hearld and Alexander 2012). However, the evidence as a whole is more mixed. One systematic review found reductions in ED utilization among a majority of the studies where this outcome was assessed (Hoff, Weller, and DePuccio 2012). However, another found that out of 14 PCMH demonstration projects, only three used "rigorous" evaluation of the medical home's impact on ED utilization, of which only one intervention showed significant reductions (Peikes et al. 2012). A third meta-analysis looked at observational studies and randomized, controlled trials (RCTs) separately: three observational studies showed reductions in ED utilization, but only the RCTs evaluating older adults showed any significant reduction (Jackson et al. 2013). This finding adds weight to earlier research showing that the positive effects of PCMH model adoption appear to be concentrated among subpopulations with complex medical needs (Flottemesch et al. 2012).

Data

Program Description

The data for this project were obtained from Independence Blue Cross (IBC) of Pennsylvania. IBC is the largest commercial health plan in the Philadelphia area and was a key figure in Pennsylvania's Chronic Care Initiative, a multi-stakeholder effort aimed at improving the quality of primary care for patients with chronic illness. All data used to perform this analysis were de-identified and accessed in compliance with the Health Insurance Portability and Accountability Act. As a retrospective analysis of a de-identified database, the research was exempt from IRB review under 45 CFR 46.101(b)(4). Medical practices participating in the program were required to achieve PCMH designation from the NCQA at Level 1 or higher. Practices which achieved PCMH recognition were also provided with supplemental payments in order to cover the expenses associated with infrastructure improvements and required additional training. As of November 2012, 280 practices in the IBC network were recognized as having implemented the PCMH model. These practices are responsible for the care of more than a third of all IBC's commercially insured HMO patients in Pennsylvania, including IBC members enrolled in Medicare Advantage plans.

Using patient-level data for the years 2008 through 2011, we focus on one specific set of outcomes – ED utilization and expenditures – for approximately 460,000 Health Plan HMO members. Because of concerns that practices which never received recognition as a PCMH might exhibit inherent differences from practices that achieved PCMH status, our analysis was limited to only those practices which converted to PCMH status between March 2008 and November 2012.

From the complete IBC data set of 947 practices with a patient panel size of 300 or more, we identified 280 which made the switch to PCMH status during the study window. These practices represent a diverse cross-section of primary care fields: 130 were designated "family practice" clinics, with an additional 87 identified as "internal medicine;" a further 55 were labeled as "pediatrics" clinics. The remaining practices (8) were spread across other multispecialty clinics. Sixty-four of the practices studied were located within the city of Philadelphia, with the remainder found throughout the Philadelphia suburbs. Nearly two-thirds of these practices (178) achieved Level 3 PCMH status, the highest level recognized by the NCQA. Of the remaining clinics, 79 and 23 received Level 1 and Level 2 recognition, respectively.

Patients enrolled in an IBC Preferred Provider Organization (PPO) plan were excluded from the study, as they were not required to select a primary care physician and could not be reliably attributed to any one practice. Finally, member-years with unusually high ED expenditures[1] were also excluded (approximately a third of a percent of the sample). Applying these exclusion criteria generated two datasets: the first includes 1,083,773 patient-year observations; and a second comprised of 459,676 patient-years for members enrolled during the entire study period. We analyzed chronically ill patients separately from those without chronic illness, in order to ascertain whether and to what extent the transition to a PCMH framework affects such patients in terms of ED utilization and costs. Chronic illness is defined here by diagnosis of any of the following: asthma, hypertension, coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), or diabetes. An attrition diagram describing these steps in detail appears in Appendix A.

Covariates

Patient-Level Characteristics A number of other variables from the IBC dataset were used to control for patient and practice attributes. In addition to basic demographic traits like gender and age, each patient-year observation also includes a risk score estimated using the model developed by Verisk Health DxCG Risk Solutions, which incorporates clinical and demographic data for each patient (Verisk Health Inc. 2010). Information about insurance plan type (individual vs. family coverage, an indicator for capturing whether the patient was the subscriber or a dependent, and whether the group providing insurance coverage was self-funded or fully insured) is also included in order to control for differences in plan benefit structure. Further demographic information (including annual income, rate of college graduation and information on race and ethnicity) for each patient's zip code of residence was also extracted from the 2000 Census (U.S. Census Bureau 2002). Additionally, we are able to observe the day-of-week for each ED encounter, and construct an indicator variable for weekend ED visits. Note that because the hour of ED visit was not available, we could not perfectly assign visits as occurring when practices were open or closed to patients. Hence the day-of-week serves as a proxy.

Practice-Level Characteristics A number of practice descriptors, such as panel size, location (Philadelphia vs. rest of southeastern PA), and medical specialty were included. Summary statistics describing this pool of eligible patient-years appear in Table 1.

Empirical Framework

We estimate the aggregate effects of a practice switching to PCMH status on ED utilization and associated medical costs using an empirical difference-in-differences approach. This research design employs a novel identification strategy which exploits the fact that the transition to PCMH status occurred at different times across primary care clinics, so patient outcomes could be tracked before and after the switch at different points in time and across practices. These effects were estimated using the model specified below:

(1) $$Y_{it} = \lambda_t + \mu_{i/j} + A_{it} + \beta \cdot X_{jit} + \delta_1 \cdot (Post \cdot PCMH)_{it} + \delta_2 \cdot (During \cdot PCMH)_{it} + \phi_{it} + Frac_{it} + \varepsilon_{it}$$

The outcome variable Y_{jit} expresses the likelihood, number of ED visits, or the expenditures associated with those visits, for patient *j* enrolled at primary care practice *i* during year *t*. The key explanatory variables are $(During\ x\ PCMH)_{it}$ and $(Post\ x\ PCMH)_{it}$, which are indicator variables capturing each practice's PCMH status during a given year. $(During\ x\ PCMH)_{it}$ equals 1 if an observation was recorded during the year of practice *i*'s transition to PCMH status and is set to zero otherwise; $(Post\ x\ PCMH)_{it}$ equals 1 in subsequent years and zero otherwise. $Frac_{it}$ captures the fraction of the transition year during which practice *i* had achieved PCMH recognition.[2] Distinguishing between the transitional year in which the switch to the PCMH model was made and subsequent full-years of PCMH status is important, given the documented challenges of PCMH implementation in the literature (Harbrecht and Latts 2012; Berenson et al. 2008; Kilo and Wasson 2010). Studies of other health system reforms, including the Massachusetts health insurance reforms, have noted the importance of accounting for such transitional periods in analytical design (Joynt et al. 2013; Chandra, Gruber, and McKnight 2011). λ_t is a year fixed effects term. We employ two different sets of specifications, using practice fixed effects (μ_i) and using patient fixed effects (μ_j), respectively, in order to account for the characteristics of individual practices or patients.

Additionally, the model expressed in equation (1) controls for a range of patient and practice characteristics. A_{it} captures clinic characteristics including physician panel size and number of physicians per practice, as well as time-invariant clinic characteristics such as location within Philadelphia, practice specialty and NCQA certification level. X_{jit} captures time-varying patient characteristics such as risk score, age, and comorbidities, as well as time-invariant attributes such as gender, insurance plan details, and residence. X_{jit} also includes time-invariant characteristics of the zip code in which the patient resides, including median household income, percent of residents with college degrees, percent African American, and percent Hispanic, as reported in the 2000 decennial Census. The error term ε_{jit} represents the remaining, unobserved variation in patient and practice attributes.

Results

In this section, we present estimates of the impact of primary care practices switching to PCMH status on ED utilization and costs as derived by estimating equation (1). Table 2 provides estimates for the impact of PCMH adoption on the likelihood and number of ED visits, as well as the expenditures associated with such visits for patients with and without chronic illnesses.

The rows of Table 2 labeled "Post x PCMH" and "During x PCMH" show the estimated coefficients derived from equation (1) with respect to four different outcomes: likelihood of an ED visit; number of ED visits, conditional on at least one ED visit occurring; ED visit expenditures; and ED visit expenditures, conditional on non-zero expenditures. We employ this model in four different pairings of sample and specification. First, practice fixed effects are used and all eligible patients are analyzed. Next, the same specification is used again, but only for patients who have four full years of continuous enrollment in the IBC data. Subsequently, patient fixed effects are substituted into the model in place of practice fixed effects, and the model is re-run using first all patient-year observations and then using only the panel data. Each combination of specification and sample was used to analyze patients with and without chronic illness separately. The columns labeled [1] through [4] refer to the following specifications, respectively: practice fixed effects, all patients; practice fixed effects, panels sample only; patient fixed effects, all patients; and patient fixed effects, panel sample only. Results for patients with chronic illness appear in the top half of the table, and patients without chronic illness appear below.

The first four columns of Table 2 show a significant and negative correlation between the *(Post x PCMH)*$_{it}$ term and the likelihood of an ED visit for chronically ill patients. With respect to the four specifications used here, switching to PCMH status was associated with a reduction in the likelihood of an ED visit between 0.9% and 1.5%. Additionally, the negative association between the *(During x PCMH)*$_{it}$ term and likelihood of an ED visit was shown to be significant in three of the four specifications, although the effects during the transition year were roughly halved in terms of magnitude. This analysis also showed a significant, negative correlation between the *(Post x PCMH)*$_{it}$ term and ED expenditures for patients with chronic illness, ranging between $2.85 and $3.81 per-member per-year.

These results differ from our findings with respect to patients without chronic illness, shown in the bottom half of Table 2. We see that the *(Post x PCMH)*$_{it}$ term was not significantly correlated with any of the outcomes we selected, under any of the specifications used. Moreover, the direction of the association for ED visit expenditures changes, as the *(Post x PCMH)*$_{it}$ now shows a positive (though non-significant) correlation with ED expenditures.

For Table 3, we repeated the analysis used for Table 2, but limited our outcome variables (likelihood of any ED visit; number of ED visits, conditional on at least one weekend visit) to reflect only ED visits occurring on Saturdays and Sundays. In addition to serving as a robustness check on the findings in Table 2, using these results we can begin to disentangle the two hypothesized channels for the PCMH effect on ED utilization – improved chronic illness management versus expanded access. Since primary care clinics are frequently closed to patients on weekends, we treat weekends as a proxy for "clinic closed," and weekdays as a proxy for "clinic open." If the PCMH effect were primarily a result of expanded office hours, we would expect to find greater effect sizes for ED utilization when most primary care clinics are closed. As in Table 2, we find no effect on the likelihood or number of ED visits for patients without chronic illness when limiting the analysis to weekends. For chronically ill patients, the *(Post x PCMH)*$_{it}$ term is still associated with a significant reduction in the likelihood of an ED visit, but the effect is of smaller magnitude than when looking at visits on any day of the week.

Table 4 contributes additional texture to the finding that the apparent PCMH effect on ED visits and expenditures was limited to patients with chronic illness by splitting this group into its six constituent disease categories. We find smaller, statistically insignificant effects on the likelihood of a visit for asthma, CAD, and CHF, and found a significant reduction in likelihood for only one specification in the case of COPD. However, three of the specifications yielded significant reductions for patients with hypertension, along with all four in the case of patients with diabetes, among whom the likelihood of an ED visit was reduced by 1.4% to 2.3% per patient-year.

Finally, we present results from two additional models, used as robustness tests in exploring the number of ED visits per patient-year (Table 5). The first is a fixed effects ordered logit model. Such models are appropriate when the dependent variable is measured on an ordinal scale and has multiple categories. We group patient-year observations into categories of 0, 1, 2, 3, and 4 or more ED visits. We also use clustered standard errors in the model, allowing for observations to be independent across members, but not necessarily within members over time. In addition, we employ a fixed effects Poisson regression model, which expresses the natural logarithm of the event of interest as a linear function of a set of predictors in cases where the dependent variable is a nonnegative count of the event of interest (in this analysis, the number of ED visits that occur over a period of a year). Using this regression model provides another method for calculating accurate parameter estimates, as it is designed to fit count data.

The results from both models were quantitatively similar to those shown in Tables 2 and 4. For the fixed effects ordered logit model, the resulting coefficient estimates for *(Post x PCMH)*$_{it}$ are then transformed into odds ratios (ORs) for interpretation. For chronically ill patients, we find an OR of 0.933 when analyzing all patient-years and 0.920 when restricting our analysis to the panel data. The second analysis employs the fixed effects Poisson regression, and the resulting coefficient estimates were transformed to incidence rate ratios (IRRs) associated with the switch to PCMH. For chronically ill patients, the IRR is 0.939 (for all patients) and 0.912 (for patients with the full panel data). Both models incorporate information on the number of ED admissions per patient per year rather than the likelihood of at least one ED visit, as is the case in Tables 2 through 4.

The reliability of results from difference-in-differences analysis depends critically upon confirming the assumption of parallel trends, which requires that the error term is uncorrelated with the term of interest *(Post x PCMH)*$_{it}$. This assumption is important in our context, as early adopters of the PCMH model may be different than late adopters on both observable and unobservable dimensions, which may lead to issues with selection bias in our results. For example, practices that met (or were close to meeting) NCQA certification standards required comparatively minimal investments in order to receive certification. Nevertheless, such selection on the timing of certification would bias our results towards not finding an effect of PCMH status on the likelihood of ED visits, as early switchers would not have experienced drastic changes in operations and standards of service. The parallel trends assumption can be tested by plotting the time effect coefficient estimates from equation (2), which follows, versus time-to-switch.

(2) $$Y_{jit} = \lambda_t + \mu_i + \beta \cdot X_{ji} + \sum_{\Delta=Min\Delta}^{\Delta=Max\Delta} \delta_\Delta \cdot 1(t - t_i^{MH} = \Delta) + \ldots + \varepsilon_{jit}$$

When plotting the coefficient estimates and standard errors for the various time-to-switch indicator variables, no trend is visible in the pre-period, confirming the parallel trends assumption. The full set of plots used can be found in Appendix B.

Discussion

Our analysis provides consistent evidence that the adoption of the PCMH model by primary care practices lowers the likelihood of an ED visit for chronically ill patients. Consistent with prior work (Flottemesch et al. 2012), no such effects were found for patients without chronic illness. This heterogeneity in the impact of the PCMH model suggests that the magnitude of the effect depends on the fraction of avoidable ED visits. For low medical-need patients without chronic illness, there are comparatively few ED visits to prevent. In our data, more than 18% of patient-year observations in the chronically-ill patient group included at least one ED visit, compared to less than 12% in the patient group without chronic illness.

Even within the population of patients with chronic illness, we find that the reductions in ED visits were concentrated among certain subpopulations - namely, patients with diabetes and hypertension. Diabetes has been of particular interest to researchers studying the PCMH model (Bojadzievski and Gabbay 2011), in part because it has been identified as an illness where early intervention and active management can offset long-term complications and reduce the substantial human and economic costs they impose (Clark et al. 2000). Though there is disagreement regarding whether the PCMH model should be applied to all patients or limited to relevant subpopulations (Berenson et al. 2008), these findings suggest that the magnitude of the PCMH effect depends on the increased fraction of avoidable ED visits among chronically ill patients as compared to patients without chronic illness.

Additionally, our finding of smaller effect sizes for the $(Post \times PCMH)_{it}$ term when looking at weekend ED visits in isolation suggests that the apparent benefits of transitioning to PCMH status are not simply caused by patients substituting primary care for services from the ED. Examining the distribution of ED encounters by day-of-week for patients with chronic illness, we find that it is nearly uniform, with the percentage of visits by day ranging from 13.6% (on Tuesdays and Wednesdays) to 15.4% (on Mondays). Taken together with the finding of a significant overall PCMH effect on ED utilization, this finding suggests that the reductions shown occurred at least in part as a result of better management of chronic illness by PCMH-certified primary care practices.

Importantly, this study offers a number of methodological improvements including use of a dataset which represents over a million patient-years and 280 practices that received PCMH certification over five years. The large number of observations and the ability to exploit the timing of switch to PCMH status allowed for the use of practice or patient fixed effects terms to account for unobserved time-invariant practice or patient characteristics. We also find that these results are robust to various specifications (patient and practice fixed effects for a stable panel of patients, practice fixed effects ordered logit and practice fixed effects Poisson regressions). This robustness suggests that the PCMH effects shown are not merely a misattribution of other dimensions of primary care practice organization.

As pointed out above, the determinants for the timing of PCMH certification for individual practices is difficult to ascertain and is largely beyond the scope of this study. Since such understanding may yield insights into the challenges and promise of transitioning a practice to the PCMH model (Crabtree et al. 2011), we believe it should be a part of the future PCMH research agenda. While further work is needed to study other dimensions of the cost and quality impacts of the PCMH, these findings suggest that among relevant chronic illnesses, the PCMH model may be an effective tool for reducing unnecessary or inappropriate ED utilization.

Notes

1. "Unusually high ED expenditures" were defined by adding three times the inter-quartile range to the 75th percentile ED expenditure
2. Results are robust to the exclusion of $Frac_{it}$

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Table 1a: Summary Statistics – Patient Attributes

	All Patients		Patient Panel	
Mean/Proportion	**Chronic**	**Non-Chronic**	**Chronic**	**Non-Chronic**
N	393,317	690,456	193,435	266,241
Year of Observation				
2008	0.242	0.257	0.224	0.269
2009	0.269	0.258	0.246	0.253
2010	0.248	0.246	0.261	0.242
2011	0.241	0.239	0.268	0.237
PCMH	0.293	0.303	0.316	0.305
Chronic Illness				
Asthma	0.366		0.345	
Hypertension	0.621		0.648	
CAD	0.193		0.204	
COPD	0.115		0.115	
CHF	0.090		0.090	
Diabetes	0.256		0.259	
Risk Score	5.00	0.99	4.12	0.91
Other Demographics				
Age	52.11	30.28	54.27	32.30
Female	0.557	0.550	0.559	0.556
Philadelphia Resident	0.291	0.284	0.286	0.280
African American (zip 2000)	0.194	0.175	0.187	0.173
Hispanic (zip 2000)	0.032	0.033	0.031	0.032
Annual Income (zip 2000)	$51,859	$53,204	$52,273	$53,659
College Grads (zip 2000)	0.296	0.316	0.298	0.320
Single Contract Member	0.573	0.394	0.588	0.362
Subscriber Member	0.739	0.556	0.759	0.553
Self-funded Member	0.125	0.165	0.134	0.194
Medicare Advantage	0.294	0.030	0.340	0.039
Outcomes				
ED Visits	0.184	0.119	0.176	0.123
# of ED Visits *	1.44	1.26	1.37	1.24
ED Expenditures **	$87.1	$107.6	$59.9	$61.1

* Conditional on one or more visits; ** Conditional on non-zero expenditures

Table 1b: Summary Statistics –Practice Attributes

	All Patients		Patient Panel	
	Chronic	**Non-Chronic**	**Chronic**	**Non-Chronic**
Panel Size	2133.1	2214.8	2125.1	2215.3
Practice in Philadelphia	0.295	0.298	0.290	0.298
Internal Medicine	0.362	0.244	0.380	0.259
Family Practice	0.517	0.487	0.500	0.458
Pediatric	0.118	0.264	0.118	0.279
CRNP *	0.003	0.005	0.002	0.003

* Certified Registered Nurse Practitioner

Table 2: The Effect of PCMH on the Likelihood of, Number of, and Expenditures for Emergency Department Visits, for Patients with and without Chronic Illness

								----- ALL CHRONIC PATIENTS -----								
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Dependent Variable	**Likelihood of ED Visit**				**Number of ED Visits (Conditional)**				**ED Visit Expenditures**				**ED Visit Expenditures (Conditional)**			
Post x PCMH	**-0.00965*** **	**-0.00897***	**-0.0146*** **	**-0.0130*** **	-0.0293	-0.0454	-0.0554	**-0.0894** **	-2.158	**-2.853** **	**-3.805*** **	**-3.099*** **	-6.103	**-12.53** **	-10.12	-13.23
	[0.00372]	**[0.00511]**	**[0.00398]**	**[0.00476]**	[0.0266]	[0.0303]	[0.0426]	**[0.0441]**	[1.468]	**[1.144]**	**[1.332]**	**[1.064]**	[7.731]	**[6.293]**	[11.88]	[8.680]
During x PCMH	**-0.00562** **	-0.00401	**-0.00767*** **	**-0.00555***	-0.0185	**-0.0352***	**-0.0476***	-0.0451	-0.188	0.604	-0.486	0.318	1.264	4.654	-0.239	0.214
	[0.00237]	[0.00323]	**[0.00249]**	**[0.00307]**	[0.0169]	**[0.0189]**	**[0.0274]**	[0.0291]	[0.933]	[0.724]	[0.834]	[0.687]	[4.908]	[3.937]	[7.627]	[5.730]
Observations	393,317	195,178	393,317	195,178	72,382	34,467	72,382	34,467	393,317	195,178	393,317	195,178	72,382	33,964	72,382	33,964
R-squared	0.039	0.041	0.532	0.408	0.034	0.039	0.807	0.688	0.012	0.017	0.652	0.394	0.029	0.04	0.822	0.72
								----- ALL NON-CHRONIC PATIENTS -----								
Dependent Variable	**Likelihood of ED Visit**				**Number of ED Visits (Conditional)**				**ED Visit Expenditures**				**ED Visit Expenditures (Conditional)**			
Post x PCMH	-0.000837	0.000156	-0.00112	0.000781	0.0197	0.0213	0.00802	0.025	0.879	0.913	1.147	1.436	7.002	9.609	11.5	15.46
	[0.00234]	[0.00372]	[0.00266]	[0.00347]	[0.0147]	[0.0209]	[0.0323]	[0.0370]	[1.193]	[0.931]	[1.015]	[0.879]	[9.827]	[7.570]	[15.74]	[13.94]
During x PCMH	-0.00144	-0.00032	0.000309	8.75E-05	0.0102	0.0218	0.0337	0.0303	0.76	0.405	0.312	0.599	5.918	3.318	-6.043	9.264
	[0.00150]	[0.00240]	[0.00168]	[0.00230]	[0.00939]	[0.0134]	[0.0207]	[0.0248]	[0.763]	[0.602]	[0.642]	[0.584]	[6.264]	[4.846]	[10.10]	[9.326]
Observations	690,456	268,543	690,456	268,543	82,316	33,158	82,316	33,158	690,456	268,543	690,456	268,543	82,316	32,709	82,316	32,709
R-squared	0.024	0.033	0.526	0.38	0.027	0.035	0.804	0.694	0.005	0.007	0.73	0.348	0.015	0.016	0.894	0.661
Practice Fixed-Effects	✓	✓			✓	✓			✓	✓			✓	✓		
Patient Fixed-Effects			✓	✓			✓	✓			✓	✓			✓	✓
Patient Panel Sample		✓		✓		✓		✓		✓		✓		✓		✓

Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table 3: The Effect of PCMH on the Likelihood of Weekend ED Utilization

	ALL NON-CHRONIC PATIENTS								ALL CHRONIC PATIENTS							
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Dependent Variable	**Likelihood of *Weekend* ED Visits**				**Number of *Weekend* ED Visits (Cond)**				**Likelihood of *Weekend* ED Visits**				**Number of *Weekend* ED Visits (Cond)**			
Post x PCMH	-0.00047	-0.00227	-0.00097	-0.00176	0.00494	0.00733	-0.0535	-0.00487	**-0.00725*** **	-0.00446	**-0.00651** **	**-0.00538***	**-0.0405***	**-0.0473***	-0.0745	-0.0725
	[0.00148]	[0.00237]	[0.00174]	[0.00229]	[0.0117]	[0.0161]	[0.0460]	[0.0472]	**[0.00243]**	[0.00330]	**[0.00268]**	**[0.00319]**	**[0.0214]**	**[0.0254]**	[0.0642]	[0.0676]
During x PCMH	-0.00019	6.60E-05	0.000747	0.000722	0.008	0.0126	0.0163	0.029	**-0.00430*** **	**-0.00476** **	**-0.00584*** **	**0.00561*** **	-0.011	-0.0163	-0.00812	-0.0144
	[0.000947]	[0.00153]	[0.00110]	[0.00152]	[0.00745]	[0.0103]	[0.0300]	[0.0318]	**[0.00154]**	**[0.00209]**	**[0.00168]**	**[0.00206]**	[0.0136]	[0.0160]	[0.0424]	[0.0469]
Observations	690,456	266,241	690,456	266,241	29,907	11,880	29,907	11,880	393,317	193,435	393,317	193,435	26,187	12,082	26,187	12,082
R-squared	0.008	0.012	0.484	0.321	0.021	0.031	0.87	0.826	0.015	0.016	0.488	0.345	0.031	0.049	0.825	0.723
Practice Fixed-Effects	✓	✓			✓	✓			✓	✓			✓	✓		
Patient Fixed-Effects			✓	✓			✓	✓			✓	✓			✓	✓
Patient Panel Sample		✓		✓		✓		✓		✓		✓		✓		✓

Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table 4: The Effect of PCMH on the Likelihood of Emergency Department Visits by Chronic Condition

Dependent Variable						----- **ALL CHRONIC PATIENTS** -----						
Likelihood of ED visit	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Chronic Condition	**Asthma**				**Hypertension**				**Coronary Artery Disease (CAD)**			
Post x PCMH	-0.00081	-0.00327	-0.00679	-0.00782	**-0.00911***	-0.00868	**-0.0122****	**-0.0101***	-0.00235	-0.00015	-0.0117	-0.00769
	[0.00651]	[0.00930]	[0.00698]	[0.00859]	**[0.00470]**	[0.00627]	**[0.00509]**	**[0.00598]**	[0.00938]	[0.0123]	[0.0101]	[0.0117]
During x PCMH	-0.00534	-0.0006	-0.0021	1.25E-05	-0.00342	-0.002	**-0.00722****	-0.00379	-0.00337	-0.00044	-0.00805	-0.00521
	[0.00414]	[0.00589]	[0.00436]	[0.00555]	[0.00298]	[0.00395]	**[0.00318]**	[0.00384]	[0.00583]	[0.00756]	[0.00612]	[0.00725]
Observations	143,900	67,863	143,900	67,863	244,294	125,985	244,294	125,985	75,729	39,693	75,729	39,693
R-squared	0.039	0.042	0.552	0.429	0.042	0.043	0.541	0.422	0.039	0.043	0.524	0.409
Chronic Condition	**Congestive Heart Failure (CHF)**				**Chronic Obstructive Pulmonary Disease (COPD)**				**Diabetes**			
Post x PCMH	-0.0208	-0.0125	-0.0133	-0.00832	-0.0144	-0.0125	**-0.0226***	-0.0211	**-0.0137***	**-0.0196***	**-0.0228*****	**-0.0202****
	[0.0147]	[0.0198]	[0.0163]	[0.0190]	[0.0125]	[0.0170]	**[0.0137]**	[0.0162]	**[0.00748]**	**[0.0101]**	**[0.00791]**	**[0.00941]**
During x PCMH	-0.00181	-0.00208	-0.00357	0.00133	0.00213	0.005	-0.00441	-0.000147	-0.00687	**-0.0118***	**-0.0112****	**-0.0101***
	[0.00915]	[0.0121]	[0.00981]	[0.0117]	[0.00779]	[0.0104]	[0.00822]	[0.00995]	[0.00472]	**[0.00635]**	**[0.00492]**	**[0.00603]**
Observations	35,212	17,618	35,212	17,618	45,158	22,320	45,158	22,320	100,679	50,288	100,679	50,288
R-squared	0.035	0.05	0.559	0.44	0.042	0.048	0.557	0.431	0.047	0.047	0.529	0.403
Practice Fixed-Effects	✓	✓			✓	✓			✓	✓		
Patient Fixed-Effects			✓	✓			✓	✓			✓	✓
Patient Panel Sample		✓		✓		✓		✓		✓		✓

Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Table 5: Fixed effects Ordered Logit and Poisson Regressions

FIXED EFFECTS ORDERED LOGIT REGRESSION					**FIXED EFFECTS POISSON REGRESSION**				
Dependent Variable	**Ordinal number of ED Visit**				*Dependent Variable*	**Total Number of ED Visits**			
	Chronic		**Non-Chronic**			**Chronic**		**Non-Chronic**	
Post x PCMH	**-0.0693***** **[0.0259]**	**-0.0829***** **[0.0348]**	-0.0025 [0.0225]	-0.0085 [0.0349]	Post x PCMH	**-0.0628**** **[0.0295]**	**-0.0798***** **[0.0252]**	0.00329 [0.0189]	-0.0183 [0.0302]
During x PCMH	**-0.0414***** **[0.0164]**	-0.0304 [0.0219]	-0.01547 [0.0142]	-0.0067 [0.0223]	During x PCMH	-0.0293 [0.0199]	**-0.0405**** **[0.0170]**	-0.00587 [0.0130]	-0.00554 [0.0208]
Observations	393,317	193,435	690,456	266,241	Observations	393,253	193,381	690,400	266,044
Pseudo R-squared	0.0316	0.0331	0.0253	0.0345	Number of Groups	185	167	189	165
Practice Fixed-Effects	✓	✓	✓	✓	Practice Fixed-Effects	✓	✓	✓	✓
Patient Panel Sample		✓		✓	Patient Panel Sample		✓		✓
Cluster patient ID	✓	✓	✓	✓					
	ODDS RATIOS					**INCIDENT RATE RATIOS**			
Post x PCMH	**0.933*****	**0.920*****	0.997	0.991	Post x PCMH	**0.939****	**0.912*****	1.003	0.982
During x PCMH	**0.959*****	0.970	0.985	0.993	During x PCMH	0.987	**0.962****	0.994	0.994

Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Appendix A: Attrition Diagram

Observations (Patient-Year)	**Clinics** (Panel size >300)	
3,303,346	**947**	Starting sample: all IBC HMO health plan members and clinics in Pennsylvania between 2008 and 2011
1,103,841	**280**	Exclude all clinics that did not switch into a Patient Centered Medical Home status between 2008 and 2012
1,087,454	**280**	Exclude all HMO members who ever switched to PPO plans (*i.e.* include only Health Plan HMO members between 2008-2011)
1,083,773	**280**	Exclude member years with unusually high ED expenditures per ED visit (> Q(.75) + 3*IQR)
459,676	**280**	Patient panel sample includes member enrolled in a Health Plan HMO during the entire sample period (all 4 years)

Appendix B: Testing for Parallel Trends

Differential Time Effects Relative to PCMH Switch Date
[ER Visits for All Chronic Patients]