

Association Between the Patient-Centered Medical Home and Healthcare Utilization

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The US healthcare system is struggling with unsustainable costs and suboptimal quality.¹ Experiments with transformative delivery of healthcare, combined with payment reform, are under way across the country. The patient-centered medical home (PCMH) is a model of primary care that seeks to transform healthcare delivery by improving coordination of care, leveraging the capabilities of electronic health records (EHRs), and restructuring physician reimbursement. This model aims to decrease healthcare costs while improving quality, physician experience, and patient satisfaction.

Whether the PCMH is achieving its goal of controlling healthcare costs is not clear,^{2,4} and previous studies have had mixed results. For example, several studies have found reductions in some but not all of the healthcare utilization outcomes considered,⁵⁻¹² with reductions in emergency department (ED) visits being the most common finding.^{5,6,10,12} However, other studies have found no association between the PCMH and healthcare utilization or cost.¹³ Previous studies have typically been conducted in integrated delivery systems^{10,11} or with single health plans,⁵⁻¹¹ and they do not generally reflect the more common multi-payer, small-practice, community-based setting.²

If the PCMH model controls costs, the extent to which this is actually attributable to EHRs is unknown, as EHRs alone have been shown to affect healthcare delivery by improving quality and safety, for example.^{14,15} Whether any financial effect of the PCHM model is driven by EHRs within the PCMHs or by the added transformation that the PCMH model entails—such as changes to the roles and responsibilities of different physicians and staff members—has important implications for clinical practice and health policy. Studies that consider the PCMH model as a whole, without separating the effects of EHRs, might misattribute financial effects to one intervention or the other.

In a multi-payer community, we studied the effects of the PCMH on changes over time in 7 healthcare utilization outcomes: primary care visits, specialist visits, radiology and

ABSTRACT

Objectives: The patient-centered medical home (PCMH) model of primary care is being implemented widely, with unclear effects on healthcare utilization. How much any effect is driven by electronic health records (EHRs), a core component of PCMHs, is unknown. Our objective was to determine any association between the PCMH model and healthcare utilization and to isolate that effect from any by the EHR alone.

Study Design: We conducted a prospective cohort study (2008-2010) of 275 primary care physicians and 230,593 patients in the Hudson Valley, a multi-payer region in New York state with predominantly small practices.

Methods: We considered 3 groups: physicians who implemented Level III PCMHs in 2009, as per the National Committee for Quality Assurance, all of whom also used EHRs ($n = 92$); physicians using paper medical records ($n = 119$); and physicians using EHRs without the PCMH ($n = 64$). We used negative binomial regression to determine associations between study group and change over time for each of 7 utilization measures, adjusting for 10 physician characteristics.

Results: For every 100 patients whose physicians transformed to PCMHs, there were 21 fewer specialist visits over time compared with patients whose physicians used paper records ($P = .03$), and 22 fewer specialist visits over time compared with patients whose physicians used EHRs without the PCMH ($P = .05$). There were no significant differences over time in primary care visits, radiology tests, laboratory tests, emergency department visits, admissions, or readmissions.

Conclusions: The PCMH was associated with a significant decrease in the rate of specialist visits, the most expensive type of ambulatory visit, 1 year after PCMH implementation.

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other diagnostic tests, laboratory tests, ED visits, hospital admissions, and 30-day re-admissions. This kind of comprehensive assessment enables not only measurement of financial effects within 1 type of healthcare utilization, but also potential cost-shifting across types of utilization. We primarily compared PCMH practices with non-PCMH practices (either paper-based or EHR practices) and then further compared the PCMH with the EHR alone.

Take-Away Points

The patient-centered medical home (PCMH) is being implemented widely, with unclear effects on healthcare utilization. How much any effect is driven by electronic health records (EHRs), a core component of PCMHs, is unknown.

- We considered 3 groups of primary care physicians in a multi-payer, multi-provider community: physicians who implemented the PCMH (all of whom also used EHRs), physicians who used paper medical records, and physicians who used EHRs without the PCMH.
- The PCMH group experienced a 6% decrease in specialist visits compared with each of the other groups, but no change in other healthcare utilization, 1 year after PCMH transformation.

METHODS

Overview

We conducted a longitudinal cohort study of primary care physicians in the Hudson Valley region of New York over 3 years (2008-2010). The PCMH was implemented in 2009; therefore, 2008 represents care prior to implementation, and 2010 represents care approximately 1 year post implementation. The Institutional Review Boards of Weill Cornell Medical College and Kingston Hospital approved the protocol. The study was registered with the National Institutes of Health Clinical Trials Registry (NCT00793065).

Setting and Context

The Hudson Valley consists of the 7 counties immediately north of New York City. This study evaluates part of the Hudson Valley Initiative, which seeks to transform healthcare delivery through health information technology, practice transformation, and value-based purchasing.¹⁶ This initiative is the combined work of THINC,¹⁷ a nonprofit, coalition-building organization; the Taconic Independent Practice Association (IPA),¹⁸ a nonprofit physician organization; and MedAllies,¹⁹ a for-profit health information services provider.

For this initiative, THINC convened 6 health plans (3 national commercial plans: Aetna, UnitedHealthcare, and Empire Blue Cross Blue Shield; 2 regional commercial plans: MVP Healthcare and Capital District Physicians' Health Plan; and 1 regional Medicaid health maintenance organization, Hudson Health Plan), which together cover approximately 70% of the community's commercially insured population. The health plans agreed to provide financial incentives, which amounted to \$2 to \$10 per patient per month, to practices that implemented Level III PCMHs, as defined by the 2008 National Committee for Quality Assurance (NCQA) standards.^{20,21}

Practice Transformation

Practices that became PCMHs were assisted in their transformation by the Taconic IPA and 2 external consulting groups. Lead physicians from each practice met at least monthly as a medical council to share best practices. Practice transformation consisted of systematically reviewing the NCQA tool, documenting PCMH processes already in place, and implementing processes not initially in place. Practice-based needs assessments began in January 2009, and actual transformation began in March 2009. All practices submitted their applications to NCQA and were awarded Level III recognition (the highest level); the median submission date was December 2009. Three major themes emerged as central to the transformation process for these practices: changing the culture toward population management, building a team by clearly defining roles and responsibilities, and becoming accountable for performance.

Data

We used the following physician characteristics, as collected by the IPA in 2008: age, gender, degree (MD vs DO), specialty, county, and adoption of a practice management system. The number of primary care physicians in the physician's practice was obtained in 2008, 2009, and 2010. EHR status was derived from a comprehensive survey of physicians in the community in 2010. This survey, which predated the federal Meaningful Use program, confirmed the presence of an EHR by collecting data on the EHR vendor and software version number.

Five of 6 health plans contributed claims for calendar years 2008, 2009, and 2010 to a third-party data aggregator, which ensured completeness and adherence to standardized specifications. The data aggregator attributed each claim to a specific patient and then attributed each patient to a primary care physician (eAppendix, available at www.ajmc.com). All of the patient's healthcare utilization was assigned to the primary care physician to whom the patient was attributed, regardless of who ordered the healthcare

services. We captured 7 different categories of healthcare utilization: 1) primary care visits (including visits to primary care physicians and nurse practitioners), 2) specialist visits, 3) radiology and other diagnostic tests, 4) laboratory tests, 5) ED visits, 6) hospital admissions, and 7) 30-day all-cause readmissions. These 7 were chosen because together, they represent the large majority of all healthcare utilization and because measuring them separately allows us to capture any shifts in healthcare utilization from 1 category to another.

The data aggregator generated 3 additional physician characteristics for each year: the total number of patients attributed to each physician from the participating health plans (panel size), case mix, and plan mix. Case mix was derived using DxCG software.²²⁻²⁴ Plan mix was a series of 5 physician-level variables—1 for each health plan—which expressed the proportion of the physician's attributed patients covered by that plan.

Statistical Analysis

We considered the physician to be the unit of analysis. We selected this approach due to the structure of the data set received by the research team, which was aggregated at the level of the physician. We conducted a sensitivity analysis adjusting for clustering by practice, although the study was not powered to find an effect at that level.

We started with all providers in the Taconic IPA in 2008 and included only primary care physicians (general internists and family medicine physicians) practicing in the Hudson Valley who had any patients in the aggregated claims. We then required a minimum number of patients per physician to maximize reliability. Previous work, using only patients with diabetes, suggested that a minimum panel size of 100 yields reliability estimates of 0.80 or greater.²⁵ Because the patients in this study reflected the full spectrum of health states and not just diabetes, we chose a minimum panel size of 200 attributed patients per physician per year. This strategy helped to ensure that the study sample would generate statistically reliable estimates and would yield results that could be generalized to other full-time clinicians.

We classified physicians into 3 study groups: those transforming into PCMHs (all of whom were also using EHRs), those using paper medical records, and those using EHRs (but not in PCMHs). We compared the groups' characteristics using analysis of variance (ANOVA) for continuous variables and χ^2 tests for categorical variables, except for the comparison for practice size, for which we used a Kruskal-Wallis test due to the non-normal distribution. Panel size was log-transformed for statistical tests.

We created 7 regression models, 1 for each healthcare utilization outcome. We used negative binomial regres-

sion because each utilization outcome is non-negative, positively skewed, and overdispersed (that is, the mean is smaller than the variance).^{26,27} This technique also allowed us to adjust for repeated measures over time. For hospital readmissions, we used zero-inflated negative binomial regression because this outcome also had a larger than expected number of zero counts.²⁶

We calculated rates of utilization for each provider, incorporating panel size in the denominator to yield observed events per 100 patients. We averaged rates of utilization across providers within study group and within each year. Using the coefficients from the negative binomial models, we calculated the adjusted difference-in-differences between study groups over time. The difference-in-differences design was chosen because it captures secular trends and then tests the hypothesis that the intervention was associated with a change over time that is statistically different from the secular trend.

The multivariate models all included the following: study group (represented with 2 dummy variables for PCMH [yes/no] and EHR [yes/no]); year (represented with 2 dummy variables for 2009 [yes/no] and 2010 [yes/no], with 2008 indicated by 2 responses of no); the interactions between the study group and year variables; and the same set of potential confounders (those physician characteristics that were associated with study group in bivariate models at baseline, $P < .20$). All models allowed practice size, panel size, case mix, and plan mix to vary over time (if those variables were selected for the multivariable model). All models adjusted for clustering of patients by provider. We had complete data for all variables in the final models.

We determined the absolute adjusted difference-in-differences in healthcare utilization (over the 3-year study period across the study groups) by applying to the data the coefficients from each multivariable model. Our primary analysis compared PCMH physicians with non-PCMH physicians (those using paper medical records or EHRs without the PCMH model). Our secondary analyses involved pairwise comparisons among the 3 study groups.

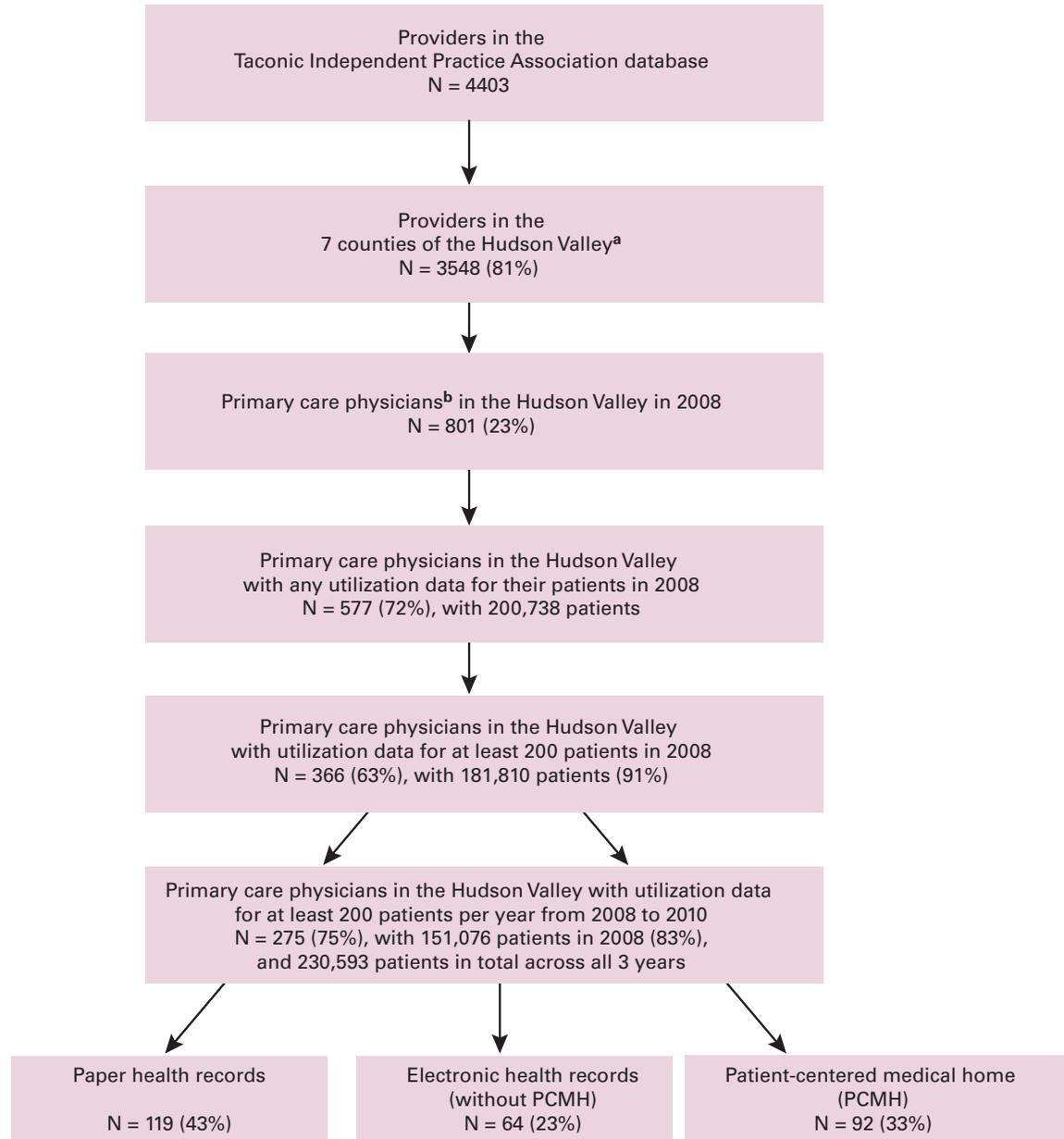
We considered $P < .05$ to be statistically significant. We used SAS version 9.2 (SAS Institute, Cary, North Carolina) for ANOVA and χ^2 tests, and STATA version 11 (StataCorp, College Station, Texas) for regression.

RESULTS

Study Sample

The **Figure** shows the derivation of the final study sample, which included 275 primary care physicians who cared for a total of 230,593 unique patients over the 3-year

■ **Figure.** Derivation of the Study Sample



^aThe 7 Hudson Valley counties are Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester.

^bPrimary care providers were defined as MDs or DOs practicing general internal medicine or family medicine.

study period. Of the 275 physicians, 119 (43%) were using paper health records, 64 (23%) were using EHRs but not the PCMH model, and 92 (33%) were using the PCMH model (with EHRs as well). This corresponded to 92 practices using paper medical records, 35 practices using an EHR alone, and 11 practices that implemented the PCMH.

Physician Characteristics

Nearly one-third of physicians in the study were female (Table 1). The average age was 50 years, and most

physicians had MD degrees. Approximately half were general internists and half were family physicians; 1 in 5 physicians worked in a rural county. The average practice size was 14 physicians, and the average number of attributed patients per physician was 549. The average case mix score was 3.4. The average physician had patients distributed across all 5 health plans.

Physicians in the PCMH practices were younger, more likely to be general internists, more likely to come from larger practices, and more likely to have practice manage-

■ **Table 1.** Characteristics of Primary Care Physicians at Baseline, Overall, and Stratified by Study Group

Physician Characteristics	Total N = 275	By Study Group			P ^a
		Paper Health Records N = 119	Electronic Health Records (without PCMH) N = 64	Patient-Centered Medical Home (PCMH) N = 92	
Gender, female: n (%)	80 (29)	29 (24)	18 (28)	33 (36)	.19
Age, years (as of December 31, 2008): mean (SD)	50 (9)	52 (10)	51 (8)	46 (8)	<.0001
Degree, MD (vs DO): n (%)	239 (87)	109 (92)	50 (78)	80 (87)	.04
Specialty: n (%)					.002
General Internal Medicine	156 (57)	63 (53)	28 (44)	65 (71)	
Family Medicine	119 (43)	56 (47)	36 (56)	27 (29)	
Rural county: n (%)	60 (22)	33 (28)	13 (20)	14 (15)	.09
Practice size^b: mean (SD)	14 (18)	4 (6)	8 (9)	33 (18)	<.0001
Panel size: mean (SD)	549 (312)	511 (231)	568 (322)	585 (385)	.50
Case mix: mean (SD)	3.4 (1.2)	3.4 (1.3)	3.4 (1.2)	3.4 (1.2)	>.99
Plan mix: mean % of panel covered by each plan					.29
Plan A	30	25	28	39	
Plan B	33	37	35	25	
Plan C	4	4	4	3	
Plan D	7	5	7	11	
Plan E	26	29	26	22	
Adopted practice management system: N (%)	178 (65)	68 (57)	31 (48)	79 (86)	<.0001

^aP values are generated with analysis of variance (ANOVA) for continuous variables and χ^2 tests for categorical variables. The Kruskal-Wallis test was used for practice size, due to non-normal distribution. Panel size was log-transformed prior to application of ANOVA.

^bPractice size was defined as the number of general internists, family physicians, and pediatricians in the practice, including the participant.

ment systems compared with their peers ($P < .05$; Table 1). Physicians using paper records were most likely to have MD degrees ($P = .04$). There were no significant differences in physician gender, county, panel size, case mix, or plan mix.

Rates of Utilization

Table 2 shows the absolute unadjusted rates per 100 patients for each utilization outcome for each year, thereby illustrating the relative volume of each outcome, with laboratory tests being the most frequent and readmissions being the least frequent. The top half of Table 2 shows the absolute rates for the PCMH group versus the non-PCMH groups (paper or EHRs alone), and the bottom half of Table 2 shows the absolute rates for each of the 3 groups separately.

When we measured adjusted differences across study groups over time, we found that for every 100 patients whose primary care physicians practiced in a PCMH model, there were 21 fewer specialist visits over time compared with patients whose primary care physicians were in non-PCMH practices (Table 3). Similarly, for every 100 patients whose primary care physician practiced in a PCMH model, there were 21 fewer specialist visits over

time compared with patients whose primary care physicians used paper records, and 22 fewer specialist visits over time compared with patients whose primary care physicians used EHRs alone (Table 3). The adjusted relative reduction in specialist visits was 6% compared with physicians using paper ($P = .03$) and 6% compared with physicians using EHRs alone ($P = .045$).

There were no statistically significant differences across study groups over time for the other outcomes for the physician-level analyses: primary care visits, radiology tests, laboratory tests, ED visits, hospital admissions, or readmissions. There were no statistically significant differences across study groups over time for any of the 7 outcomes when we adjusted for clustering by practice.

DISCUSSION

In this 3-year study of 275 primary care physicians and more than 230,000 patients, we found that patients whose primary care physicians practiced in PCMHs used fewer specialist visits over time than patients whose primary care physicians were in other types of practices 1 year post-PCMH implementation. The magnitude of this

■ **Table 2.** Absolute Unadjusted Rates of Healthcare Utilization Over the 3-year Study Period

Utilization Measure	Study Group	Observed Mean Rates (SD) per 100 Patients		
		2008	2009	2010
PCMH vs non-PCMH				
Primary care visits	Non-PCMH	312.7 (80.0)	320.4 (86.1)	304.7 (88.3)
	PCMH	261.7 (51.0)	269.6 (63.2)	255.5 (65.8)
Specialist visits	Non-PCMH	329.1 (95.7)	347.5 (99.8)	346.9 (109.9)
	PCMH	351.8 (104.9)	364.6 (109.8)	368.4 (99.7)
Radiology and other diagnostic tests	Non-PCMH	212.9 (58.5)	210.1 (55.4)	189.7 (55.6)
	PCMH	219.5 (54.5)	212.5 (42.5)	194.5 (44.0)
Laboratory tests	Non-PCMH	1262.4 (421.7)	1346.5 (467.1)	1279.2 (489.3)
	PCMH	1327.6 (394.5)	1376.8 (336.5)	1352.1 (358.5)
ED visits	Non-PCMH	19.4 (13.2)	19.6 (14.2)	19.0 (15.7)
	PCMH	23.1 (14.8)	25.0 (20.4)	26.5 (27.8)
Hospital admissions	Non-PCMH	7.9 (4.6)	7.0 (4.1)	6.8 (4.4)
	PCMH	8.8 (3.4)	8.6 (4.6)	8.2 (5.2)
Hospital readmissions	Non-PCMH	1.7 (1.5)	1.4 (1.3)	1.5 (1.6)
	PCMH	1.7 (1.2)	1.6 (1.8)	1.5 (1.6)
PCMH vs EHR^a vs paper				
Primary care visits	Paper	320.2 (89.4)	329.9 (94.8)	315.0 (99.1)
	EHR	298.8 (56.5)	302.7 (64.1)	285.5 (59.5)
	PCMH	261.7 (51.0)	269.6 (63.2)	255.5 (65.8)
Specialist visits	Paper	328.3 (102.3)	348.2 (108.2)	343.0 (114.6)
	EHR	330.6 (82.8)	346.3 (82.6)	354.0 (101.2)
	PCMH	351.8 (104.9)	364.6 (109.8)	368.4 (99.7)
Radiology and other diagnostic tests	Paper	216.1 (60.3)	212.7 (57.5)	191.1 (58.0)
	EHR	206.8 (54.7)	205.3 (51.3)	187.0 (51.3)
	PCMH	219.5 (54.5)	212.5 (42.5)	194.5 (44.0)
Laboratory tests	Paper	1261.4 (428.6)	1346.5 (486.5)	1273.8 (518.6)
	EHR	1264.4 (411.8)	1346.6 (432.3)	1289.4 (433.2)
	PCMH	1327.6 (394.5)	1376.8 (336.5)	1352.1 (358.5)
ED visits	Paper	18.9 (13.3)	19.0 (14.4)	18.5 (16.2)
	EHR	20.5 (13.0)	20.5 (13.8)	19.8 (14.8)
	PCMH	23.1 (14.8)	25.0 (20.4)	26.5 (27.8)
Hospital admissions	Paper	8.0 (5.0)	7.1 (4.5)	6.7 (4.7)
	EHR	7.7 (3.8)	6.8 (3.1)	7.0 (3.7)
	PCMH	8.8 (3.4)	8.6 (4.6)	8.2 (5.2)
Hospital readmissions	Paper	1.8 (1.7)	1.5 (1.4)	1.6 (1.7)
	EHR	1.7 (1.2)	1.3 (0.9)	1.4 (1.2)
	PCMH	1.7 (1.2)	1.6 (1.8)	1.5 (1.6)

ED indicates emergency department; EHR, electronic health record; PCMH, patient-centered medical home.

^aEHR here specifically indicates a practice's use of electronic health records without the PCMH model.

effect was 21 fewer specialist visits over time for every 100 patients whose primary care physicians practiced in PCMHs, compared with patients in other types of practices, which is equivalent to an absolute reduction of 6%. We found no statistically significant differences in any of the other utilization outcomes (ie, primary care visits, laboratory tests, radiology tests, ED visits, hospital admissions, or readmissions).

One of the mechanisms by which the PCMH is expected to work is through the provision of more contact between primary care practices and patients, especially patients with chronic disease. If patients receive more primary care, including more coordinated care, then they may require less specialty care. Our observation of significantly fewer specialist visits is consistent with this proposed mechanism, as is the trend toward more primary

Table 3. Absolute Adjusted Difference-in-Differences for Rates of Healthcare Utilization Over the 3-year Study Period

Utilization Measure	Study Group	Mean Differences in Rates Over Time (95% CI) per 100 Patients ^a	P
PCMH vs non-PCMH			
Primary care visits	PCMH vs non-PCMH	9.4 (–4.1 to 22.9)	.17
Specialist visits	PCMH vs non-PCMH	–21.4 (–39.5 to –3.2)	.02
Radiology and other diagnostic tests	PCMH vs non-PCMH	–6.6 (–17.6 to 4.3)	.24
Laboratory tests	PCMH vs non-PCMH	35.3 (–37.5 to 108.1)	.34
ED visits	PCMH vs non-PCMH	0.8 (–1.0 to 2.6)	.37
Hospital admissions	PCMH vs non-PCMH	0.0 (–0.8 to 0.7)	.92
Hospital readmissions ^b	PCMH vs non-PCMH	Unable to estimate	.90
PCMH vs EHR^c vs paper			
Primary care visits	EHR vs paper	–6.3 (–16.6 to 4.0)	.23
	PCMH vs paper	5.3 (–9.1 to 19.7)	.47
	PCMH vs EHR	10.6 (–2.1 to 23.3)	.095
Specialist visits	EHR vs paper	0.4 (–16.6 to 17.5)	.96
	PCMH vs paper	–21.0 (–40.1 to –2.0)	.03
	PCMH vs EHR	–21.7 (–43.0 to –0.5)	.045
Radiology and other diagnostic tests	EHR vs paper	1.5 (–7.9 to 10.9)	.76
	PCMH vs paper	–7.1 (–18.9 to 4.7)	.24
	PCMH vs EHR	–8.1 (–19.1 to 2.9)	.16
Laboratory tests	EHR vs paper	13.4 (–69.3 to 96.0)	.75
	PCMH vs paper	38.9 (–40.6 to 118.5)	.34
	PCMH vs EHR	25.8 (–64.8 to 116.3)	.58
ED visits	EHR vs paper	0.6 (–1.2 to 2.5)	.50
	PCMH vs paper	1.1 (–0.8 to 3.1)	.23
	PCMH vs EHR	0.5 (–1.8 to 2.8)	.66
Hospital admissions	EHR vs paper	0.4 (–0.5 to 1.3)	.38
	PCMH vs paper	0.1 (–0.8 to 0.9)	.88
	PCMH vs EHR	0.3 (–1.1 to 0.6)	.49
Hospital readmissions ^b	EHR vs paper	Unable to estimate	.78
	PCMH vs paper	Unable to estimate	.76
	PCMH vs EHR	Unable to estimate	.97

ED indicates emergency department; EHR, electronic health record; PCMH, patient-centered medical home.

^aEstimated absolute mean difference-in-differences with 95% CI were calculated using negative binomial regression, adjusting for clustering by provider and adjusting for covariates (gender, age, degree, specialty, county, practice size, practice management system, health plan).

^bThe model for hospital readmissions was generated with zero-inflated negative binomial regression, with admissions and health plan as the predictors causing inflation. Because readmissions were so rare, it was not possible to generate stable estimates of the estimated differences and 95% CI.

^cEHR here specifically indicates a practice's use of electronic health records without the PCMH model.

care visits. Specialist visits represent a significant portion of healthcare expenditures,²⁸ accounting for nearly 45% of all physician office visits.²⁹ Specialist visits tend to be the costliest type of ambulatory visit and can result in subsequent testing costs. The optimal proportion of primary care-to-specialist visits in the United States is not defined, and this issue will continue to be important.

The PCMH model strives to improve care coordination and to advance payment reform.^{30,31} It is one of several novel models of healthcare delivery, including accountable care organizations and bundled payments.³²

These models move away from fee-for-service reimbursement and instead pay for the care of patients from the perspective of a health system, even if that system includes multiple providers that were traditionally not linked financially. Whether or not the PCMH model emerges in the upcoming era as a dominant form of healthcare delivery, the lessons learned will apply to other new models that similarly emphasize care coordination and payment reform.

We are aware of 1 other study that found an association between the PCMH and fewer specialist visits.⁹

That study was a cross-sectional, 12-month, single health plan study in Minnesota with claims data from 2008 in which all providers (regardless of PCMH status) were using EHRs.⁹ Other studies found reductions in ED utilization, including in the same health plan in Minnesota,⁶ in an integrated delivery system in Washington state,¹⁰ in a single-health-plan study in Connecticut,⁵ and in a multi-payer study in Rhode Island.¹² The magnitude of these effects was usually modest and did not always translate into cost savings.^{5,12} Still, other studies, such as the recent multi-payer study from Pennsylvania, found no effect.¹³ The reasons for the variations in the results are not completely understood. One of the ways in which the studies varied was in the degree to which they could measure the adoption of EHRs.

There is a paucity of studies on the effects of EHRs on patients' healthcare utilization. Much of the literature has focused on the providers' perspective, such as the time to a positive return on investment or work flow efficiency.³³ This study thus contributes to the literature on the effects of EHRs on healthcare utilization, while also demonstrating that the financial effects of the PCMH are not driven entirely by EHRs.

All of the PCMH practices in this study had EHRs and also put into place the organizational changes required by the PCMH model of primary care, including changing the culture toward population management, building a team by clearly defining roles and responsibilities, and becoming accountable for performance. At least 2 of these (population management and becoming accountable) are enabled by EHRs and are difficult to achieve without them. Thus, the study's results suggest that it was the combination of EHRs and organizational change that were associated with the observed reduction in specialist visits over time. This study also builds on our previous work, which found an association between the PCMH and modest improvement in quality over time,³⁴ and between the PCMH and greater patient satisfaction with access to care.³⁵

Limitations and Strengths

This study has several limitations. First, this was an observational study, and we cannot exclude the possibility of selection bias. The physicians who chose to implement the PCMH came from larger practices, and we adjusted for practice size, which has been shown to be an important marker of PCMH readiness.^{36,37} We did not have data on all potential confounders, such as the duration of EHR use or other aspects of organizational culture. However, with the exception of 2 randomized controlled trials (1 including 36 prac-

tices and the other including 37 practices), we are unlikely to see other randomized controlled trials, due to the challenges of executing those types of studies for healthcare delivery.^{5,38} Second, the PCMH is a multi-component intervention, and we cannot determine from this study which aspect of the PCMH was most important in driving the changes we observed. We also do not have information on any PCMH-like processes that may be in place at the control practices. Third, the duration of follow-up was approximately 1 year post PCMH implementation; longer follow-up may be needed to observe the full effects. Fourth, this study does not measure healthcare costs, and it is possible that changes in healthcare utilization do not translate into proportional changes in healthcare costs. Finally, this study considered the 2008 standards of NCQA, and more difficult standards have subsequently been released by NCQA (in 2011 and 2014). Our results are likely still generalizable, because the practices in this study adopted the highest level of the 2008 standards. Future studies are needed to explore the effects of the subsequent standards, which build on the ones we studied.

This study has several strengths. First, it took place in a multi-payer, multi-provider community, which maximizes generalizability. The aggregated claims data used for this study represent the kind of effort that is needed to study the rapidly changing healthcare landscape. Second, we considered 7 different categories of healthcare utilization, which allowed us to measure not only changes within each category over time but also to capture any cost-shifting across categories. Third, the practices studied used a standardized definition of PCMH transformation, the NCQA 2008 Level III definition. This definition has been used widely across many but not all of the existing PCMH demonstration projects.³⁹ Finally, we used rigorous epidemiologic and statistical methods, including 2 concurrent control groups, a 3-year longitudinal design, and adjustment for multiple potential confounders, including plan mix.

CONCLUSIONS

In summary, this study suggests that the PCMH can decrease specialist visits by 6% more than non-PCMH practices within 1 year after implementation, without causing an increase in ED visits or hospital admissions. This study also demonstrates the feasibility and importance of studying health system change in a community-based setting, which remains relevant, as other forms of healthcare innovation build on the principles of the PCMH. The PCMH-associated reductions in specialist visits may have been driven by organizational changes in the practices, which were enabled by but distinct from the EHR.

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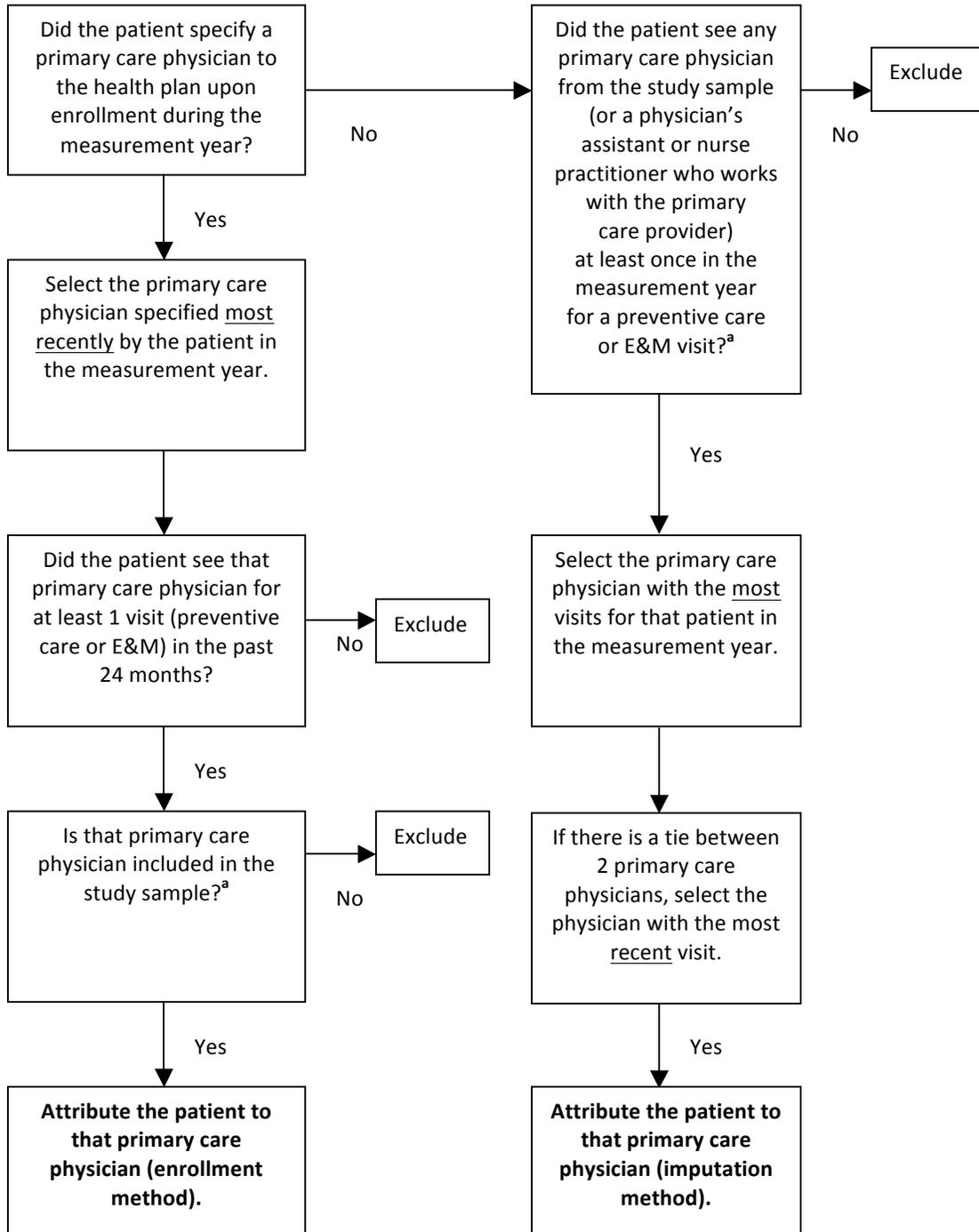
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eAppendix. Logic for Attributing Patients to Providers



E&M indicates evaluation and management.

^aSee Figure for a derivation of the study sample.