Patient-Centered Medical Home Cost Reductions Limited to Complex Patients

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Objectives: To examine the long-term relationships between costs, utilization, and patient-centered medical home (PCMH) clinical practice systems.

Study Design: Clinical practice systems were evaluated at baseline by the Physician Practice Connections-Research Survey (PPC-RS). Annual costs and utilization of a retrospectively constructed cohort of 58,391 persons receiving primary care at 1 of 22 medical groups over a 5-year period (2005-2009) were compared.

Methods: Multivariate regressions adjusting for patient demographics, health status, and autoregressive errors compared PPC-RS scores and study outcomes for the entire cohort and 3 subcohorts defined by medical complexity (medication count 0-2 [n = 29,657], 2-6 [n = 19,505], ≥7 [n = 9229]). Outcomes (adjusted to 2005 dollars) were total costs, outpatient costs, inpatient costs, inpatient days, and emergency department (ED) use.

Results: For the entire cohort, a 10% increase in PPC-RS scores was associated with 3.9 (medication count: 0-2), 6 (3-6), and 11.6 (≥7) fewer ED visits per 1000 in 2005; and 5.1, 7.6, and 13.6 fewer ED visits in 2009. That 10% increase was not associated with the 0-2 medication subcohort's total (–$22/person in 2005; $184/person in 2009), outpatient (–$11/person in 2005; $42/person in 2009), or inpatient ($26/person in 2005; $29/person in 2009) costs. However, it was associated with significantly decreased total (–$446/person in 2005; –$184/person in 2009) and outpatient (–$241/person in 2005; –$54/person in 2009) costs for the most medically complex subcohort (≥7 medications).

Conclusions: Association of PCMH clinical practice systems with reduced costs appears limited to the most medically complex patients.

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For author information and disclosures, see end of text.

The patient-centered medical home (PCMH) is a topic of interest.[1-15] A high-functioning medical home requires coordinated care by a consistent team.[16-21] Although few clinics are PCMHs, adults reporting a usual source of primary care are 25% more likely to report positive clinician attributes[22] and reduced disparities.[23] Observational studies suggest the PCMH approach results in improved satisfaction[24] and reduced utilization.[25] Pilot studies have found reduced emergency department (ED) use[26] and cost reductions.[27-31]

Clinical practice systems are an important component of a PCMH.[32,33] They give access to relevant information, coordinate management of complex conditions, and facilitate delivery of preventive care services. The Physician Practice Connections–Patient-Centered Medical Home (PPC-PCMH), a tool endorsed by the National Committee for Quality Assurance (NCQA), measures practice systems and has been used in PCMH programs.[34-38]

Prior studies of utilization[26,39] have looked at short time frames of 12 to 24 months.[16] In theory, the PCMH would reduce medical costs over time by avoiding complications leading to ED visits and inpatient stays, especially among patients with complex illness, as suggested by the chronic care model of Bodenheimer et al.[40] This study uses a 2005 measure of the PPC-PCMH and a retrospectively constructed cohort from a large Midwestern health plan to evaluate whether clinical practice systems evaluated at baseline are associated with reduced utilization and costs over a subsequent 5-year period. We present key findings in terms of predicted annual per person amounts to illustrate (1) how predicted costs and utilization change in response to clinical systems and (2) how baseline clinic systems related to different patient groups.

METHODS

Data Sources, Study Population, and Primary Care Medical Groups

Utilization, billing, provider, medical group, and patient demographic data came from the administrative databases of a large, not-for-profit Midwestern health plan. Practice system measures came from a 2005 survey of medical group directors using the Physician Practice Connections-Research Survey (PPC-RS).[41] This instrument is similar to the PPC-PCMH except for fewer questions about the electronic medical record, a focus on 4 chronic conditions (diabetes, cardiovascular dis-

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Take-Away Points

Patient-centered medical home (PCMH) clinical practice systems have been associated with quality improvement and short-term (12-24 months) reductions in patient medical costs and utilization. Using a retrospectively constructed longitudinal cohort, we examined the association between PCMH clinical practice systems and annual medical costs and utilization over a 5-year period.

- Improved PCMH clinical practice systems were associated with reduced emergency department utilization for all patients.
- Higher-functioning baseline PCMH clinical practice systems were associated with lower total and outpatient costs for medically complex patients (ie, 7 or more active prescriptions) over 5 years.

ease, asthma, and depression), and graded response categories. A full description of the tool is available on request.

A retrospective cohort over 2005 to 2009 was constructed to compare a baseline measure of clinic systems with subsequent utilization patterns. Subjects needed to meet the following inclusion criteria: (1) have 10 or more months of continuous enrollment in each year; (2) be alive on December 31, 2009; (3) be 19 years or older as of January 1, 2005; and (4) be attributable to the same primary care medical group for 2005 to 2009. Persons were attributed to the medical group with which they had the greatest percentage of primary care visits. Primary care visits were defined as visits with providers in the following specialties: family medicine, internal medicine, general practice, geriatric medicine, and obstetrics and gynecology (Ob-Gyn). Nurse practitioner and physician assistant visits were included. Our decision to include visits with Ob-Gyn providers was made because such visits are a regular source of care for many women of childbearing age. However, such an inclusion does not strictly conform to the person-focused primary care concept of Starfield.[42] The implications of this decision are discussed in the Limitations section.

Those with no primary care visits were unattributed and excluded. Those attributed to more than 1 medical group (ie, those who had an equal number of visits to 2 or more groups) were also excluded. We further limited the sample to medical groups with a minimum of 200 attributed members. Per year, of the 318,857 adults attributed in 2005 approximately 5% were excluded due to death or disenrollment, 25% due to a change in attributed medical group, and 5% due to no primary care utilization. This resulted in 58,391 persons across 22 medical groups. Most (n = 48,292) had commercial insurance, 7077 were Medicare enrollees, and 3022 were enrolled in Medicaid. For dually eligible Medicare beneficiaries aged 65 to 75 years, all claims including pharmacy were processed by the health plan in order to track benefits, deductibles, and payer liability. All claims from Medicaid beneficiaries were processed for similar reasons.

Five annualized outcomes were constructed: total cost, total outpatient cost, total inpatient cost, inpatient days, and ED visits. The health plan's administrative databases contain information concerning insurance product, medical diagnosis, care specialty, costs, and limited demographics (age, address, and sex). These were organized using Evaluation and Management, *International Classification of Diseases, Ninth Revision*, and Current Procedural Terminology (CPT) codes. Total cost included all reimbursed medical costs, including copays, coinsurance, and deductibles. Outpatient cost included professional services, prescriptions, lab and x-ray tests, and outpatient surgical procedures. Inpatient cost included professional and facility fees for hospital-based services including emergency care. Inpatient days were days with an overnight hospital stay. ED visits included all visits to an ED with reimbursed service. If a subject was not enrolled for the entire year, their cost and utilization was annualized using their monthly average.

To avoid variation in outcomes due to benefit design or provider contract, total, outpatient, and inpatient costs were based on a standardized measure, the relative resource value unit. Relative resource value units are based on Centers for Medicare & Medicaid Services relative value units, inpatient diagnosis-related groups (DRGs), and Ambulatory Payment Classification weights. The logic is to apply a standardized fee schedule across all providers by developing standardized costs for each CPT code, hospital DRG, and National Drug Classification (NDC) code that is dependent upon the type of procedure/service/prescription provided but independent of the place of service, type of insurance coverage, or year. This fee schedule was developed by constructing a weighted average of billed amounts across all contracted providers for each CPT code, hospital DRG, and NDC code. Our measures of costs were developed by adjusting these averages by the ratio of billed to paid amounts across service category and scaled to the base year of 2005.

PPC-RS Survey

The PPC-RS[41] asks 53 questions related to delivering preventive services, depression, diabetes, cardiovascular disease, and asthma. Of these, 43 are grouped into domains corresponding to the Chronic Care Model: Health Care Organization (n = 3), Delivery System Redesign (n = 8), Clinical Information System (n = 10), Decision Support (n = 9), and Self-Management Support (n = 23). Items are coded as present and work well (1 point), present but need improvement (1/2 point), or absent (0 points). Domain scores represent the proportion of possible items present and utilized. The PPC-RS score is a summation of all items with high scores associated with higher-functioning clinical systems.

Table 1. Patient Characteristics

Characteristic	2005	2006	2007	2008	2009
Annualized total costs, mean ± SD	$10,348 ± $22,385	$10,904 ± $25,355	$11,682 ± $26,311	$12,368 ± $27,728	$13,637 ± $32,905
Number of outpatient prescriptions, mean ± SD	3.45 ± 3.53	3.71 ± 3.64	3.97 ± 3.82	4.05 ± 3.85	4.21 ± 3.94
Age, y, mean ± SD	52.31 ± 13.58	53.31 ± 13.58	54.31 ± 13.58	55.31 ± 13.58	56.31 ± 13.58
Female, %	63.61	63.61	63.61	63.61	63.61
Medicare, %	12.86	14.55	16.03	17.53	18.84
Medicaid, %	1.82	1.78	1.76	1.76	1.76
Asthma, %	10.04	10.36	10.10	9.51	9.18
CAD, %	4.83	4.94	5.06	5.22	5.46
CHF, %	0.89	1.14	1.30	1.50	1.68
COPD, %	3.62	3.93	3.92	3.64	3.34
Depression, %	23.79	24.86	25.77	26.19	26.92
Diabetes, %	9.87	10.79	11.72	12.71	13.55

CAD indicates coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SD, standard deviation.

Plan of Analysis

Multiple regression models were estimated using generalized estimating equations for continuous outcomes and generalized linear models for discrete outcomes. All models were fit with a subject-level autoregressive error structure (AR1 process). Cost outcomes were log transformed[43-46] and Duan's smearing estimator was used.[47,48] A majority had neither inpatient nor ED visits within a given year. Thus, 2 outcomes were considered. First, the likelihood of any utilization was modeled using a logistic regression with a subject-level AR1 process. Among those with inpatient costs, a log-transformation was used. For ED utilization and inpatient days, a zero-inflated Poisson model was used.

Our models compared a baseline measure of clinical systems with costs and utilization over a 5-year period. They adjusted for demographics (age and sex), complexity/comorbidity (number of medications and comorbidities), insurance type, and primary care visits. Outpatient prescription medications were our measure of complexity because this information was reliably available from claims data, and it is a validated, easily reproducible measure.[49] Certain results categorized subjects by their baseline number of prescriptions, but models allowed that number to vary by year. All of the models were developed in the following manner. First, candidate covariance structures were considered. Second, demographic models were constructed. Covariates significant at the 10% level in univariate models were screened for confounding, multicolinearity, and consistent linear relationships. Appropriate adjustments (transformations, interactions, and polynomial terms) were made. Study year was considered as both a continuous and fixed effect with a fixed-effect specification preferable (likelihood ratio test; $P = .0002$). Finally, PPC-RS scores were added, and the possibility of interactions with both study year and patient demographics was considered.

To control for variation in outcomes due to differences in patient mix when presenting our results, we used a 2-part strategy. First, as discussed, we incorporated multiple patient-level factors adjusting for patient demographics (age and sex), ability to pay (insurance type), and medical complexity (prescription drug use and comorbidities) into our final multivariate models. Second, we estimated the impact of changes in PCMH-related systems (PPC-RS scores) holding fixed patient demographics.

RESULTS

Table 1 contains demographic information and average per patient costs. Total costs averaged $10,347 (standard deviation [SD] $22,384) in 2005 and trended upward to $13,637 (SD $32,905) in 2009. The average 2005 age was 52.3 years with 64% being female, 13% using Medicare, and 1.8% using Medicaid. Over the study, an additional 6% enrolled in Medicare; however, Medicaid enrollment was stable.

Depression was the most prevalent chronic condition, impacting 24% in 2005 and 27% in 2009. The next most prevalent was asthma (10% in 2005, 9% in 2009), then diabetes (10% in 2005, 14% in 2009) and coronary artery disease (5% in 2005, 5.5% in 2009). Patients averaged 3.5 prescriptions in 2005 and 4.2 prescriptions in 2009. A brief

Table 2. Medical Group Costs and PPC-RS Scores

Medical Group[a]	No.	Estimate[b]	CL, High[c]	CL, Low[c]	PPC-RS Score
1	27,331	$10,474	$10,574	$10,376	75.3
2	8436	$10,806	$10,975	$10,640	77.9
3	6732	$11,029	$11,221	$10,841	75.3
4	3113	$11,437	$11,727	$11,154	59.7
5	2129	$9947	$10,279	$9626	65.6
6	1984	$10,663	$10,988	$10,348	76.5
7	1512	$11,070	$11,497	$10,658	78.1
8	1452	$11,315	$11,788	$10,861	46.3
9	1057	$10,752	$11,238	$10,287	56.7
10	852	$12,155	$12,765	$11,573	64.0
11	741	$10,597	$11,144	$10,078	67.9
12	656	$9900	$10,482	$9349	70.9
13	618	$10,751	$11,414	$10,127	84.5
14	609	$9982	$10,546	$9449	38.3
15	582	$11,980	$12,786	$11,225	60.3
16	463	$9022	$9653	$8431	70.3
17	446	$9437	$10,102	$8816	63.9
18	439	$10,590	$11,305	$9921	47.6
19	404	$9945	$10,689	$9255	76.7
20	324	$10,581	$11,507	$9728	24.5
21	268	$9628	$10,494	$8834	57.2
22	227	$8717	$9520	$7981	44.8

CL indicates confidence limit; PPC-RS, Physician Practice Connections-Research Survey.
[a]Medical group names removed.
[b]Column contains the average of the predicted costs for each attributed person (column 1) from a multivariate model adjusting for patient age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[c]95% confidence limits for the average of predicted costs for each attributed person in the medical group.

discussion of demographics and specific coefficient estimates is in the **eAppendix** (available at **www.ajmc.com**).

Tables 2 to **5** contain predicted amounts from our multivariate models. These predict per person costs (Tables 3 and 5) or utilization (Table 4), adjusting for patient demographics and comorbidities. They illustrate (1) how predicted costs and utilization change according to changes in baseline clinical systems (Table 3) and (2) how a hypothetical 10% improvement in baseline clinical systems potentially affects different groups differently.

Table 2 lists attributed patients and average predicted cost by medical group. Estimated average healthcare costs by medical group ranged from $8717 to $12,155. The medical group closely affiliated with the health plan had the largest attribution (n = 27,331) with an estimated cost of $10,474. Attribution to the remaining groups ranged from 8436 to 227 persons. Table 2 also lists 2005 PPC-RS scores that ranged from 25 to 85.

Relationship Between Costs and PPC-RS Scores

Aside from ED use (P <.001), no samplewide associations with the PPC-RS were found. However, significant relationships with subgroups existed. Among complex patients (≥7 medications), higher scores were associated with lower total costs, outpatient costs, inpatient days, and ED use.

Table 3 presents estimated amounts by year and quartile of baseline PPC-RS scores. In 2005, predicted per patient costs in groups whose PPC-RS score was at the sample's 3rd quartile (PPC-RS = 70.3) were approximately $100 less than those whose medical group was at the sample median (P = .025) and $240 less than those whose PPC-RS was at the lowest quartile (P <.01). This difference decreased over time, becoming negative in 2009 (P = .16). Outpatient utilization differed by $45 ($P$ = .035) and $108 ($P$ <.001) between the 3rd and lower quartiles in 2005, with the difference decreasing over time until it was associated with increases in 2008 and 2009 (P = .35 and P = .023, respectively). Higher PPC-RS quartiles were associated with in-

Table 3. Predicted Average Annualized per Person Healthcare Costs and Utilization[a]

Utilization Category	PPC-RS Score	2005, Mean (95% CLs)	2006, Mean (95% CLs)	2007, Mean (95% CLs)	2008, Mean (95% CLs)	2009, Mean (95% CLs)
Total costs[b]	25th Percentile (47.5)	$9586.54 ($9384, $9794)	$10,142.30 ($9961, $10,325)	$10,798.89 ($10,616, $10,985)	$11,209.97 ($11,006, $11,418)	$11,995.77 ($11,725, $12,272)
	Median (59.6)	$9446.38 ($9327, $9566)	$10,041.91 ($9934, $10152)	$10,742.94 ($10,628, $10,861)	$11,209.50 ($11,086, $11,333)	$12,054.26 ($11,883, $12,228)
	75th Percentile (70.3)	$9346.16 ($9257, $9436)	$9969.83 ($9885, $10,054)	$10,702.60 ($10,610, $10,797)	$11,209.16 ($11,115, $11,305)	$12,096.80 ($11,962, $12,234)
Outpatient costs[b]	25th Percentile (47.5)	$5937.45 ($5828, $6048)	$6374.23 ($6273, $6476)	$6798.48 ($6697, $6901)	$6991.74 ($6876, $7107)	$7301.32 ($7156, $7449)
	Median (59.6)	$5874.52 ($5811, $5937)	$6339.69 ($6279, $6400)	$6797.00 ($6736, $6859)	$7029.57 ($6960, $7098)	$7380.50 ($7290, $7471)
	75th Percentile (70.3)	$5829.37 ($5784, $5875)	$6314.80 ($6268, $6360)	$6795.92 ($6748, $6842)	$7057.10 ($7005, $7109)	$7438.38 ($7368, $7508)
Likelihood of inpatient care[c]	25th Percentile (47.5)	5.70% (5.29%, 6.14%)	6.16% (5.86%, 6.49%)	6.42% (6.07%, 6.79%)	6.28% (5.96%, 6.60%)	6.03% (5.58%, 6.50%)
	Median (59.6)	5.76% (5.52%, 6.01%)	5.97% (5.80%, 6.16%)	6.13% (5.94%, 6.32%)	6.07% (5.89%, 6.25%)	6.07% (5.81%, 6.33%)
	75th Percentile (70.3)	5.81% (5.65%, 5.98%)	5.81% (5.68%, 5.95%)	5.88% (5.74%, 6.03%)	5.89% (5.76%, 6.03%)	6.10% (5.91%, 6.30%)
Inpatient costs[d]	25th Percentile (47.5)	$31,277.21 ($30,222, $32,368)	$31,259.51 ($30,593, $32,573)	$31,489.37 ($30,497, $32,516)	$31,761.78 ($30,782, $32,768)	$32,416.16 ($31,304, $33,571)
	Median (59.6)	$31,358.74 ($30,587, $32,152)	$31,340.99 ($30,698, $31,995)	$31,571.45 ($30,887, $32,267)	$31,844.56 ($31,195, $32,510)	$32,500.65 ($31,656, $33,366)
	75th Percentile (70.3)	$31,417.90 ($30,730, $32,119)	$31,400.12 ($30,861, $31,945)	$31,631.02 ($31,051, $32,225)	$31,904.65 ($31,360, $32,457)	$32,561.97 ($31,798, $33,342)
Inpatient days (per 1000)[e]	25th Percentile (47.5)	84.4 (76.9, 92.3)	82.5 (71.9, 93.6)	85.2 (75.0, 96.0)	89.9 (79.2,101.2)	92.4 (80.7, 104.7)
	Median (59.6)	80.5 (72.1, 89.1)	78.9 (71.9, 86.1)	81.6 (75.2, 88.2)	86.2 (79.6, 93.0)	88.8 (80.9, 96.9)
	75th Percentile (70.3)	77.7 (71.6, 83.9)	76.3 (70.4, 82.4)	79.1 (73.9, 84.3)	83.5 (78.2, 88.9)	86.2 (79.7, 93.0)
ED use (per 1000)[e]	25th Percentile (47.5)	147.3 (134.1, 161.1)	158.1 (137.8, 179.4)	169.1 (148.7, 190.5)	176.6 (155.5, 198.7)	187.0 (163.3, 211.9)
	Median (59.6)	137.3 (123.1, 152.1)	147.4 (134.3, 161.0)	157.7 (145.4, 170.4)	164.7 (152.1, 177.7)	174.5 (159.1, 190.4)
	75th Percentile (70.3)	128.9 (118.8, 139.3)	138.4 (127.7, 149.4)	148.1 (138.5, 158.0)	154.7 (144.9, 164.7)	163.8 (151.4, 176.6)

CL indicates confidence limit; ED, emergency department; PPC-RS, Physician Practice Connections-Research Survey.
[a]All results are shown in 2005 dollars.
[b]Results from a generalized estimating equation estimation with autocorrelated error structure controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[c]Results from a logistic regression controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[d]Results from a generalized equation estimation controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[e]Results from a zero-inflated Poisson Model controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.

Table 4. Impact of 10% Increase in PPC-RS Score on Predicted Inpatient and Emergency Department Utilization

Category	No. of Medications	PPC-RS	2005, Mean (95% CLs)	2006, Mean (95% CLs)	2007, Mean (95% CLs)	2008, Mean (95% CLs)	2009, Mean (95% CLs)
Inpatient days (per 1000)[a]	0-2 (n = 29,657)	Current (mean 71.13)	45.6 (42.8, 48.4)	46.4 (42.2, 50.7)	47.6 (43.9, 51.4)	50.4 (46.6, 54.2)	51.0 (46.7, 55.4)
		10% Increase (mean 78.24)	44.5 (40.6, 48.4)	45.4 (41.2, 49.7)	46.5 (42.8, 50.4)	49.3 (45.4, 53.2)	49.9 (45.6, 54.3)
		Change due to increase	−1.11[b]	−1.06	−1.06	−1.09	−1.05
	3-6 (n = 19,505)	Current (mean 71.13)	89.0 (82.3, 96.0)	87.4 (82.6, 92.4)	91.2 (85.4, 97.1)	96.8 (90.8, 102.9)	101.7 (94.5, 109.1)
		10% Increase (mean 78.24)	87.3 (81.1, 93.7)	85.9 (79.0, 92.9)	89.6 (83.5, 95.8)	95.1 (88.9, 101.5)	100.1 (92.7, 107.7)
		Change due to increase	−1.72[b]	−1.58[b]	−1.58	−1.64[b]	−1.61
	≥7 (n = 9229)	Current (mean 71.13)	287.8 (266.7, 309.6)	266.0 (243.3, 289.4)	281.0 (260.9, 301.6)	296.4 (276.5, 316.9)	317.2 (293.7, 341.3)
		10% Increase (mean 78.24)	284.4 (262.2, 307.3)	263.0 (239.6, 287.0)	278.0 (256.9, 299.5)	293.3 (272.3, 314.8)	314.2 (289.9, 339.2)
		Change due to increase	−3.42[c]	−3.05[c]	−3.00	−3.14[c]	−2.94
ED visits (per 1000)[a]	0-2 (n = 29,657)	Current (mean 71.13)	88.3 (83.0, 93.7)	98.2 (89.4, 107.3)	105.0 (96.9, 113.3)	110.4 (102.1, 118.9)	116.4 (106.7, 126.4)
		10% Increase (mean 78.24)	84.4 (77.1, 91.9)	93.9 (85.2, 102.9)	100.4 (92.3, 108.6)	105.5 (97.3, 114.0)	111.3 (101.7, 121.2)
		Change due to increase	−3.9[b]	−4.3[c]	−4.6[c]	−4.8[c]	−5.1[c]
	3-6 (n = 19,505)	Current (mean 71.13)	142.5 (131.7, 153.6)	152.5 (144.1, 161.0)	163.5 (153.1, 174.1)	170.8 (160.3, 181.6)	182.5 (169.5, 195.8)
		10% Increase (mean 78.24)	136.6 (126.8, 146.6)	146.1 (134.4, 158.1)	156.7 (146.1, 167.5)	163.7 (153.0, 174.6)	174.9 (162.0, 188.2)
		Change due to increase	−6.0[c]	−6.4[c]	−6.8[c]	−7.1[c]	−7.6[c]
	≥7 (n = 9229)	Current (mean 71.13)	313.2 (290.2, 336.9)	313.7 (287.0, 341.3)	335.5 (311.5, 360.1)	345.3 (322.0, 369.1)	365.0 (337.9, 392.8)
		10% Increase (mean 78.24)	301.6 (278.1, 326.0)	302.0 (275.2, 329.7)	323.0 (298.6, 348.1)	332.4 (308.6, 356.7)	351.4 (324.2, 379.4)
		Change due to increase	−11.6[c]	−11.7[c]	−12.5[c]	−12.9[c]	−13.6[c]

CL indicates confidence limit; ED, emergency department; PPC-RS, Physician Practice Connections-Research Survey.
[a]Results from a zero-inflated Poisson Model controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[b]Significant at the $P = .1$ level.
[c]Significant at the $P = .05$ level.

creased inpatient utilization across all study years but less ED use. In 2005, the 3rd quartile of PPC-RS scores was associated with 8.5 and 18.4 fewer ED visits per 1000 persons compared with the median and 1st quartile ($P = .01$ and $P < .01$, respectively), and increased to 10.6 and 23.2, respectively, in 2009 ($P < .01$).

Tables 4 and 5 estimate the impact of a hypothetical 10% increase in 2005 PPC-RS scores for 3 groups defined by their number of 2005 outpatient prescriptions: 0 to 2 medications (n = 29,657), 3 to 6 medications (n = 19,505), and 7 or more medications (n = 9229). Among those with 0 to 2 medications, the 10% increase was associated with a slight increase in total, outpatient, and inpatient costs not significant at the .05 level. Among those with 3 to 6 medications, the increase was associated with a slight decrease in average total and out-

Table 5. Impact of 10% Increase in PPC-RS Score on Predicted Medical Costs[a]

Category	No. of Medications	PPC-RS	2005, Mean (95% CLs)	2006, Mean (95% CLs)	2007, Mean (95% CLs)	2008, Mean (95% CLs)	2009, Mean (95% CLs)
Total costs[b]	0-2 (n = 29,657)	Current (mean 71.13)	$4315.18 ($4268, $4363)	$5041.67 ($4944, $5141)	$5341.14 ($5295, $5387)	$5708.97 ($5660, $5758)	$6188.16 ($6124, $6253)
		10% Increase (mean 78.24)	$4293.23 ($4242, $4345)	$4924.08 ($4877, $4971)	$5343.81 ($5293, $5395)	$5724.98 ($5670, $5780)	$6227.27 ($6154, $6302)
		Change due to increase	−$21.95	−$117.59[c]	$2.67	$16.01	$39.11
	3-6 (n = 19,505)	Current (mean 71.13)	$10,294.79 ($10,194, $10,395)	$10,849.71 ($10,758, $10,941)	$11,542.53 ($11,440, $11,647)	$11,976.40 ($11,873, $12,080)	$12,954.44 ($12,824, $13,086)
		10% Increase (mean 78.24)	$10,222.98 ($10,114, $10,333)	$10,794.52 ($10,696, $10,894)	$11,505.65 ($11,397, $11,617)	$11,975.21 ($11,862, $12,088)	$12,865.36 ($12,709, $13,023)
		Change due to increase	−$71.81[c]	−$55.19	−$36.88	−$1.20	−$89.08[c]
	≥7 (n = 9229)	Current (mean 71.13)	$33,819.52 ($33,329, $34,317)	$31,063.65 ($30,705, $31,429)	$32,551.98 ($32,180, $32,928)	$32,392.87 ($32,022, $32,771)	$33,597.05 ($33,140, $34,064)
		10% Increase (mean 78.24)	$33,372.70 ($32,833, $33,921)	$30,736.11 ($30,330, $31,145)	$32,253.88 ($31,837, $32,679)	$32,160.48 ($31,736, $32,588)	$33,412.77 ($32,902, $33,931)
		Change due to increase	−$446.82[d]	−$327.54[d]	−$298.10[d]	−$232.39[d]	−$184.28[d]
Outpatient costs[b]	0-2 (n = 29,657)	Current (mean 71.13)	$3370.04 ($3338, $3403)	$3998.92 ($3932, $4067)	$4267.91 ($4237, $4298)	$4541.34 ($4507, $4576)	$4834.72 ($4792, $4878)
		10% Increase (mean 78.24)	$3358.93 ($3324, $3394)	$3913.47 ($3880, $3947)	$4279.02 ($4245, $4313)	$4564.56 ($4525, $4604)	$4877.45 ($4827, $4928)
		Change due to increase	−$11.10	−$85.45	$11.11	$23.22	$42.73
	3-6 (n = 19,505)	Current (mean 71.13)	$7573.26 ($7514, $7633)	$8145.97 ($8088, $8205)	$8729.63 ($8668, $8791)	$9030.64 ($8963, $9098)	$9572.78 ($9494, $9654)
		10% Increase (mean 78.24)	$7533.98 ($7468, $7600)	$8121.57 ($8058, $8186)	$8720.91 ($8654, $8788)	$9051.43 ($8978, $9126)	$9531.70 ($9436, $9628)
		Change due to increase	−$39.28[c]	−$24.40	−$8.73	$20.79	−$41.07
	≥7 (n = 9229)	Current (mean 71.13)	$21,473.58 ($21,232, $21,718)	$20,522.53 ($20,328, $20,718)	$21,559.64 ($21,364, $21,757)	$21,441.39 ($21,234, $21,650)	$21,881.10 ($21,635, $22,128)
		10% Increase (mean 78.24)	$21,232.29 ($20,964, $21,504)	$20,350.86 ($20,132, $20,572)	$21,419.96 ($21,198, $21,644)	$21,347.26 ($21,112, $21,586)	$21,826.46 ($21,551, $22,108)
		Change due to increase	−$241.29[d]	−$171.67[d]	−$139.68[d]	−$94.13[d]	−$54.63[d]

(Continued)

patient costs not significant at the .05 level, but with a slight increase in average inpatient costs not significant at the .05 level. Among those with 7 or more medications, there was a small decrease in average inpatient costs not significant at the .05 level, whereas outpatient costs decreased significantly by 1.12% (P <.01) in 2005 and 0.25% in 2009 (P = .015). The number of ED visits decreased by 3.7% for all 5 years (P <.01), as did the number of impatient days (P <.01).

Limitations

This work explored how a PCMH could impact utilization over time; however, it has limitations. Our inclusion criteria resulted in a final cohort that tended to be older and sicker than average. They may also have introduced a survivor bias as the top 5% to 10% of high-cost patients frequently have short life expectancies. Thus, our findings should not be interpreted as indicating PCMH's impact on total healthcare costs. Instead, our findings suggest that higher-functioning PCMH systems are associated with different levels of healthcare costs among medically stable patients who have a consistent source of primary care.

Our attribution scheme assigning patients to medical groups included Ob-Gyn visits. As noted, such a definition does not strictly conform to Starfield's definition of person-focused care that focuses on first contact: person-focused over time, comprehensiveness, and coordination.[50] Similarly, our primary variable of interest, the PPC-RS score, focuses on a medical group's structural elements and is intended to measure systems supporting

Table 5. Impact of 10% Increase in PPC-RS Score on Predicted Medical Costs[a] *(Continued)*

Category	No. of Medications	PPC-RS	2005, Mean (95% CLs)	2006, Mean (95% CLs)	2007, Mean (95% CLs)	2008, Mean (95% CLs)	2009, Mean (95% CLs)
Inpatient costs[e]	0-2 (n = 29,657)	Current (mean 71.13)	$889.87 ($840, $943)	$937.94 ($897, $981)	$952.42 ($908, $999)	$966.61 ($924, $1011)	$1011.25 ($956, $1069)
		10% Increase (mean 78.24)	$894.97 ($841, $953)	$924.95 ($881, $971)	$931.96 ($885, $981)	$947.39 ($902, $995)	$996.87 ($938, $1059)
		Change due to increase	$5.10	–$12.99	–$20.46[c]	–$19.22	–$14.38
	3-6 (n = 19,505)	Current (mean 71.13)	$1985.60 ($1885, $2091)	$1969.96 ($1893, $2050)	$2001.40 ($1918, $2089)	$2008.69 ($1930, $2091)	$2120.75 ($2011, $2237)
		10% Increase (mean 78.24)	$1996.47 ($1887, $2112)	$1942.84 ($1861, $2029)	$1960.72 ($1871, $2055)	$1977.20 ($1892, $2066)	$2174.38 ($2051, $2305)
		Change due to increase	$10.88	–$27.12	–$40.68	–$31.49	$53.62
	≥7 (n = 9229)	Current (mean 71.13)	$7043.33 ($6667, $7439)	$6114.15 ($5850, $6391)	$6403.57 ($6121, $6698)	$6310.84 ($6054, $6578)	$6544.72 ($6218, $6887)
		10% Increase (mean 78.24)	$7081.37 ($6673, $7512)	$6034.64 ($5754, $6328)	$6302.50 ($6004, $6615)	$6249.37 ($5975, $6535)	$6623.04 ($6257, $7009)
		Change due to increase	$38.05	–$79.51[c]	–$101.06[c]	–$61.46[c]	$78.32

CL indicates confidence limit; PPC-RS, Physician Practice Connections-Research Survey.
[a]All results are in 2005 dollars.
[b]Results from a generalized estimating equation estimation with autocorrelated error structure controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.
[c]Significant at the $P = .1$ level.
[d]Significant at the $P = .05$ level.
[e]Results from a 2-part model estimating likelihood of use using a logistic regression and level of use using a generalized equation estimation controlling for age,[2] sex, number of prescription medications,[2] insurance type (commercial, Medicare, Medicaid), asthma, congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, depression, and diabetes mellitus.

patient-centered care. The impact is that our findings may tend toward episodes of care rather than patient care needs over time.

The PPC-RS scores were measured at the start of our study time frame and represent a snapshot of each medical group's initial clinical systems. They do not capture system change, innovation, and improvement. Those groups with the poorest functioning systems in 2005 had both the greatest incentive and the greatest opportunity to improve. The potential for unobserved convergence is likely and could explain why differences were greatest in 2005. This highlights the need for systematic, prospective analysis.

DISCUSSION

The results of this analysis build on previous work and demonstrate how the PCMH and its associated clinical systems differ across patient groups over time. That prior work demonstrated that systems implemented at the clinic level lead to decreased utilization over relatively short periods of time. Here, over a longer, 5-year time frame, we show that among complex yet medically stable patients, who likely require the greatest amount of management and care coordination, PCMH systems measured at baseline were associated with lower costs and utilization. That is particularly true of ED care. However, as we noted, our measure of clinic performance and 5-year enrollment requirement may have introduced certain biases. Thus, findings are illustrative and not definitive.

This work is enlightening because it highlights several points regarding clinical systems and their potential impact. Initially, our approach attempted to parallel a similar analysis of quality.[51] We intended to measure the impact of implementing a PCMH using a proxy approach comparing an integrated medical group whose clinics had all achieved level III PCMH recognition with primary care medical groups that had unrecognized clinics. That analysis hypothesized that an NCQA-recognized PCMH will have significantly different trends compared with other groups. That initial comparison suggested the PCMH was unassociated with healthcare utilization and costs. However, closer inspection indicated our proxy measure (ie, recognized vs nonrecognized PCMHs) was suspect. Our medical group's PPC-RS scores, and hence the functioning of its PCMH-related systems, did not significantly differ from those of other groups. When a direct measure of PCMH-related clinical systems was used (2005 PPC-RS scores), significant relationships were found. Specifically, among relatively healthy patients as indicated by a low level of prescription drug use, higher-functioning clini-

cal systems appeared to be unassociated with medical costs and ED use. However, among the sickest and most costly patients, improved PMCH-related systems appear to have been associated with reduced costs and utilization across multiple categories.

The number of outpatient prescription medications was used as a measure of medical complexity. Other measures (the Charlson Comorbidity[52] and the Elixhauser[53] indices) were considered in sensitivity analysis with no significant change in our predicted results. We retained the number of prescription medications because it is easy to interpret, does not rely on complex algorithms, and has been shown to have higher predictive validity in similar contexts.[49]

These findings have important implications. The first is that PCMH recognition does not necessarily imply superior functioning. Many medical groups have implemented systems associated with the PCMH, even though they have not gained formal recognition. These systems appear to be having a positive effect in terms of reducing utilization by the most complex patients. However, this association could also imply that different types of patients need different types of care models. The PCMH may be useful and cost-effective for the medically complex; however, an alternative model may be preferable for others. Clearly, additional research is needed that carefully compares how the PCMH is implemented in different settings and how and why formal recognition is sought.

Another implication is that improved PCMH functioning should not necessarily imply a universal decrease in utilization and costs. Instead, it should be viewed as a changed approach to patient management and activation. For some patients, this change may lead to slightly increased utilization as they are encouraged to seek preventive care and screenings. That, in turn, could lead to reduced reliance on expensive emergency care. For other patients, reductions in utilization may indeed be realized as a result of improved management of complex, chronic disease. A better understanding of how the PCMH changes the provider/patient relationship and its long-term impact on patient outcomes is required to fully understand this dynamic.

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■ eAppendix. Summary of Demographics and Model Coefficients

The eAppendix Table contains estimated coefficients and 95% confidence limits from final multivariate models. Five models were estimated; 3 of them (inpatient costs, emergency department [ED] use, and inpatient use) were 2-part models with 2 sets of jointly estimated coefficients. The estimated coefficients in the eAppendix Table underlie the estimates provided in Tables 2 to 5 of the article. This eAppendix briefly summarizes the specification of these models and the impact of patient-level demographics.

Model Specifications

For the first 3 continuous cost outcomes (total, outpatient, and inpatient costs), we first examined the outcome variable for the correct specification. Distribution fitting indicated all 3 outcomes were exponentially distributed. Thus, a log transformation was appropriate. For inpatient costs, there was a considerable zero mass (ie, a large number of person-years with no utilization), and a 2-part model with a Heckman estimator was used.

Similarly, both ED visits and inpatient days displayed considerable zero mass. A zero-inflated Poisson model was used to estimate ED use and the number of inpatient days. The results from both parts of these estimations are provided.

All models were developed in the following manner. First, a baseline model including study year and patient-level demographics was developed. Lagrange multiplier tests significant at the .05 level were used to compare different specifications such as the inclusion of different covariates, polynomial terms, and interactions. Second, this baseline model was expanded to include comorbidities and outpatient prescriptions. Again, Lagrange multiplier tests were used to compare different model specifications. Finally, Physician Practice Connections-Research Survey (PPC-RS) scores were introduced. During each step of the process, the significance of any interactions was reassessed.

Total Healthcare Costs

Age, sex, number of outpatient prescriptions, and certain chronic diseases were related to total annual costs. Total annual costs were related to initial age and the number of outpatient prescription medications; however, relationships between these factors and annual costs were nonlinear and squared terms were added. Women had approximately 13% higher total annual costs than men (P <.001). Congestive heart failure (CHF) and coronary artery disease (CAD) were the most expensive chronic conditions. Their presence corresponded to 68% and 47% (P <.001) increases in total annual costs, respectively. Patients with depression had 18% higher total annual costs, and those with chronic obstructive pulmonary disease (COPD) had 14% higher total annual costs (P <.01). The relationship between PPC-RS scores, prescription drug use, and time as indicated by year of the study was complex. A 3-way interaction between all 3 factors was found significant at the .05 level and determined necessary to accurately model the relationship.

Outpatient Costs

Women used approximately 13.5% more outpatient care than men (P <.01). Asthma (6.5% increase), CAD (45% increase), CHF (68% increase), COPD (13% increase), depression (18% increase), and diabetes mellitus (DM) (5% increase) were all significantly related to increased outpatient costs (P < .001). As with total costs, relationships with patient age and outpatient medication use were nonlinear and squared terms were used. This resulted in a 0.2% increase per additional year of age and a 1.2% increase with each additional outpatient prescription medication. As with total costs, the relationship between PPC-RS scores, prescription drug use, and time was complex. A 3-way interaction was found significant at the .05 level and determined necessary to accurately model the relationship.

Inpatient Utilization and Emergency Department Use

Women were 2.1% (P <.001) more likely to have inpatient utilization and 1.5% (P = .008) more likely to have ED use compared with men. However, among those with inpatient use, men had 8% higher inpatient costs (P <.001) but no difference in the number ED visits (P = .36). Age was associated with both an increased likelihood of inpatient and ED use and with the amount of inpatient and frequency of ED care (P <.001). Each additional outpatient prescription medication increased the likelihood of inpatient utilization 3.5% and ED use 1.8%. Among those with inpatient utilizations, inpatient costs increased 4.2% with each additional prescription. Among those with any ED visits, the number of ED visits increased by 0.5 visits with each additional outpatient prescription. Asthma (6.5% increase; 0.05 ED visits), CAD (45% increase; 0.34 ED visits), CHF (68% increase; 0.28 ED visits), COPD (13% increase; 0.05 ED visits), depression (18% increase; 0.17 ED visits), and DM (5% increase; 0.12 ED visits) were significantly associated with inpatient costs and ED utilization, respectively.

eAppendix Table. Results from Estimated Models: Final Specification and Estimated Coefficients[a]

Variable	Total Costs	Outpatient Costs	Likelihood of Inpatient Costs	Inpatient Costs	No ED Use	Number of ED Visits	Likelihood of Inpatient Stay	Number of Inpatient Days
Intercept	7.09 (6.79, 7.39)	6.51 (6.23, 6.77)	0.11 (−0.17, 0.40)	8.06 (7.76, 8.31)	−0.63 (−0.88, 0.32)	0.62 (0.42, 0.81)	2.29 (1.61, 2.98)	−0.02 (−0.73, 0.69)
2005	0.35 (0.05, 0.64)	0.35 (0.09, 0.59)	0.09 (−0.24, 0.41)	0.02 (−0.01, 0.04)	−0.01 (−0.06, 0.04)	−0.15 (−0.19, −0.11)	−0.32 (−0.37, −0.21)	−0.48 (−0.55, −0.4)
2006	0.26 (−0.02, 0.56)	0.2813 (0.03, 0.53)	0.19 (−0.13, 0.51)	−0.01 (−0.03, 0.03)	−0.06 (−0.12, −0.01)	−0.16 (−0.21, −0.12)	−0.27 (−0.32, −0.22)	−0.32 (−0.39, −0.25)
2007	0.14 (−0.14, 0.43)	0.06 (−0.19, 0.3)	0.38 (0.06, 0.71)	0.01 (−0.02, 0.03)	−0.02 (−0.08, 0.03)	−0.11 (−0.15, −0.06)	−0.23 (−0.28, −0.18)	−0.25 (−0.32, −0.18)
2008	0.029 (−0.2, 0.30)	−0.043 (−0.2, 0.19)	0.28 (−0.04, 0.59)	−0.029 (−0.06, −0.01)	−0.064 (−0.12, −0.01)	−0.071 (−0.12, −0.03)	−0.16 (−0.21, −0.11)	−0.21 (−0.27, −0.14)
2009	***Reference***	***Reference***	***Reference***	***Reference***	***Reference***	***Reference***	***Reference***	***Reference***
PPC-RS score	0.072 (0.01, 0.14)	0.088 (0.03, 0.15)	0.001 (−0.01, 0.01)	0.012 (−0.05, 0.08)	0.009 (0.01, 0.01)	0.001 (−0.01, 0.01)	−0.499 (−0.65, −0.35)	−0.28 (−0.42, −0.13)
No. of outpatient prescriptions	0.323 (0.29, 0.36)	0.304 (0.27, 0.37)	0.216 (0.21, 0.23)	0.051 (0.04, 0.06)	−0.093 (−0.11, −0.08)	0.09 (0.08, 0.09)	0.019 (−0.03, 0.07)	−0.14 (−0.15, −0.12)
Squared term	−0.006 (−0.01, −0.01)	−0.006 (−0.01, −0.01)	−0.003 (−0.01, −0.01)	−0.001 (−0.01, 0.01)	0.002 (0.01, 0.01)	−0.001 (−0.01, −0.01)	−0.002 (−0.01, 0.01)	0.002 (0.01, 0.01)
Age	−0.002 (−0.01, 0.01)	0.01 (0.01, 0.02)	−0.131 (−0.13, −0.13)	0.051 (0.05, 0.05)	0.059 (0.05, 0.07)	−0.046 (−0.05, −0.04)	−0.064 (−0.07, −0.06)	0.106 (0.09, 0.12)
Squared term	0.01 (0.00, 0.00)	−0.01 (0.00, 0.00)	0.001 (0.001, 0.001)	−0.0004 (0.00, 0.00)	−0.0005 (−0.001, 0.000)	0.0004 (0.000, 0.000)	0.0007 (0.001, 0.001)	−0.0008 (−0.001, 0.00)

Women	0.135 (0.12, 0.15)	0.124 (0.12, 0.17)	0.083 (0.05, 0.12)	−0.082 (−0.11, −0.06)	0.069 (0.03, 0.11)	−0.015 (−0.05, 0.02)	−0.047 (−0.08, −0.01)	−0.141 (−0.19, −0.09)
Medicare	0.056 (0.035, 0.076)	0.059 (0.042, 0.077)	0.045 (−0.009, 0.099)	−0.062 (−0.09, −0.03)	0.013 (−0.058, 0.083)	0.015 (−0.04, 0.07)	−0.353 (−0.39, −0.31)	−0.428 (−0.51, −0.35)
Switch to Medicare	0.033 (0.01, 0.06)	0.0277 (0.001, 0.05)	0.0632 (0.001, 0.125)	0.0104 (−0.03, 0.05)	0.0208 (−0.06, 0.11)	−0.089 (−0.15, −0.02)	−0.0042 (−0.06, 0.05)	−0.1095 (−0.21, −0.02)
Medicaid	0.1383 (0.092, 0.185)	0.1312 (0.089, 0.173)	0.1313 (0.026, 0.236)	0.0318 (−0.03, 0.102)	−0.5108 (−0.59, −0.425)	0.514 (0.46, 0.568)	0.392 (0.303, 0.481)	0.235 (0.11, 0.36)
Asthma	0.0637 (0.04, 0.08)	0.0837 (0.07, 0.098)	−0.1046 (−0.15, −0.05)	−0.0693 (−0.11, −0.04)	−0.1507 (−0.21, −0.09)	0.0707 (0.03, 0.11)	−0.193 (−0.24, −0.15)	−0.0935 (−0.17, −0.02)
CAD	0.4721 (0.45, 0.494)	0.2597 (0.24, 0.276)	1.0463 (0.996, 1.096)	0.0995 (0.068, 0.13)	−0.3125 (−0.376, −0.25)	0.2277 (0.18, 0.27)	−0.0193 (−0.062, 0.024)	−1.4917 (−1.59, −1.39)
CHF	0.6886 (0.646, 0.731)	0.2156 (0.186, 0.245)	1.3958 (1.3, 1.48)	0.3392 (0.29, 0.386)	−0.3871 (−0.49, −0.29)	0.1473 (0.087, 0.21)	0.238 (0.197, 0.28)	−1.7635 (−1.92, −1.61)
COPD	0.1322 (0.11, 0.16)	0.0897 (0.067, 0.112)	0.4317 (0.36, 0.49)	−0.0209 (−0.06, 0.02)	−0.1012 (−0.18, −0.03)	0.0963 (0.046, 0.15)	0.1201 (0.076, 0.16)	−0.4956 (−0.59, −0.4)
Depression	0.1757 (0.17, 0.19)	0.1666 (0.16, 0.18)	0.1608 (0.13, 0.19)	0.0198 (−0.003, 0.04)	−0.1939 (−0.23, −0.15)	0.1745 (0.14, 0.21)	0.4782 (0.445, 0.51)	0.2897 (0.24, 0.34)
Diabetes	−0.0537 (−0.07, −0.036)	−0.0398 (−0.05, −0.02)	−0.1006 (−0.14, −0.054)	−0.0344 (−0.06, −0.01)	0.1895 (0.135, 0.24)	−0.1205 (−0.16, −0.08)	0.0846 (0.05, 0.12)	0.2215 (0.16, 0.28)
2-Way Interactions								
PPC-RS score × 2005	−0.1009 (−0.17, −0.031)	−0.1028 (−0.16, −0.04)	0.0006 (−0.01, 0.01)					
× 2006	−0.079 (−0.147, −0.01)	−0.0827 (−0.14, −0.03)	−0.002 (−0.006, 0.002)					
× 2007	−0.0454 (−0.12, 0.02)	−0.0247 (−0.08, 0.033)	−0.0051 (−0.01, −0.001)					
× 2008	−0.0118 (−0.12, 0.02)	0.0053 (−0.08, 0.033)	−0.0032 (−0.01, −0.001)					

× No. of outpatient prescriptions	−0.0128 (−0.02, −0.004)	−0.0121 (−0.02, −0.01)					0.0223 (0.011, 0.034)	
3-Way Interactions								
PPC-RS score×								
No. of outpatient prescriptions × 2005	0.0026 (0.002, 0.003)	0.0021 (0.002, 0.003)						
× 2006	0.0012 (0.001, 0.002)	0.0007 (0.000, 0.001)						
× 2007	−0.0001 (−0.01, 0.01)	−0.0006 (−0.01, 0.00)						
× 2008	0 (−0.01, 0.01)	−0.0003 (−0.01, 0.00)						

CAD indicates coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; ED, emergency department; PPC-RS, Physician Practice Connections-Research Survey.

[a]Values are estimated coefficients (confidence limits).