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Are Characteristics of the Medical Home Associated with Diabetes Care Costs?

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Abstract

Objective—To examine the relationship between primary care medical home clinical practice systems (PCMH clinical practice systems) corresponding to the domains of the Chronic Care Model and diabetes-related healthcare costs incurred by members of a health plan who have diagnosed Type 2 diabetes and received care at one of 27 Minnesota-based medical groups over a 12-month period.

Study Design—Cross-sectional analysis of patient-level cost data in relation to the presence of PCMH clinical practice systems by Chronic Care Model domain using the Physician Practice Connections Readiness Survey (PPC-RS).

Methods—Multivariate regressions adjusting for patient demographics, health status and comorbidities estimated the relationship between the presence of PCMH clinical practice systems as measured by the PPC-RS and three outcomes: total diabetes-related healthcare costs, ambulatory care management costs, and potentially avoidable costs (e.g. unscheduled inpatient and emergency care).

Results—Two domains of PCMH clinical practice systems as measured by the PPC-RS were significantly associated with reductions in potentially avoidable costs. These were Health Care Organization (p=.04) and clinical reminder systems in the Decision Support domain (p=.01). Compared to medical groups with only quality improvement, those with improved Health Care Organization defined as performance measurement and individual provider feedback averaged $245/patient less. Similarly, medical groups with clinical reminders for counseling averaged $338/patient less.

Conclusions—PCMH clinical practice systems that correspond to some domains of the Chronic Care Model are related to reduced inpatient and emergency care costs. Further research is needed about how these systems impact costs over time.

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Keywords

medical home; clinical practice systems; decision support; utilization; diabetes; costs; chronic care model

Introduction

Healthcare spending continues to increase well beyond the rate of other sectors of our economy. Specific to this research, patients with diabetes consume 250% more healthcare resources compared to peers without diabetes.(1) Unfortunately, there have not been commensurate improvements in quality,(2–8) and there is ample evidence of variation in resource use and quality across physicians and medical groups.(9–13)

The concept of a Patient-Centered Medical Home (PCMH), which originated with the American Academy of Pediatrics in 1967, is receiving increased attention as a potential means to improve care.(14–20) Payers, purchasers, and policy makers see it as a vehicle for moderating costs and improving quality.(21–28) High functioning medical homes may facilitate the patient-centeredness in primary care resulting in improved patient satisfaction.(29) For example, adults reporting a usual source of care are 25% more likely to report positive clinician attributes(30), and reduced racial and ethnic disparities have also been identified.(31)

Clinical practice systems are recognized as an important component of the PCMH. NCQA has developed a tool, the Physician Practice Connection (PPC)®, that measures the use of defined practice systems and is being used in many of the PCMH pilot programs. (32–36) Prior research has indicated that use of some of the same clinical practice systems posited as part of the medical home, result in improved clinical care, such as in patients with diabetes.(37) Although some reports of implementation of PCMH like models of practice have reported cost reductions(38–43), studies linking the use of specific systems to resource use/cost are lacking.(44)

In order to address this need, we conducted a secondary data analysis of the relationship between clinical practice systems and annual diabetes costs. The research described in this paper explores the relationship between the research version of the PPC tool, and costs of care for patients with diabetes. It focuses upon three outcomes: 1) total cost of care, 2) ambulatory management costs, and 3) potentially avoidable costs (e.g. unplanned hospital stays and/or emergency department use).

Methods

Study Population and Data Sources

We performed a retrospective analysis of cross-sectional data from 2005–06. The unit of analysis is diabetic patients enrolled in HealthPartners (HP), a large non-profit Minnesota-based insurer. All study subjects met the following criteria: (a) 12 months of continuous enrollment with less than a 15-day interruption, (b) age 19–75 years inclusive on 1/1/2005, (c) alive on 12/31/06, (d) a modified Charlson comorbidity score less than 3, and (e) an

established diagnosis as of the beginning of the 12-month period. The modified Charlson comorbidity score excluded diabetes as a condition in its calculation. Consistent with prior studies(9, 10, 45–48), patients with a score of 3 or greater were excluded because of the high likelihood of death and confounding disease burden. We defined diabetes using the following validated definition that closely matches that used in physician-level HEDIS diabetes quality measures: 1) one or more inpatient or two or more outpatient ICD-9 codes 250.xx, or 2) a filled prescription for a diabetes-specific medication other than a biguanide. Biguanide use required at least one 250.xx code, because it is used for other conditions. We excluded codes for gestational diabetes. This method is 94% sensitive with a positive predictive value of 0.94.(49)

Patients received primary care from one of 27 Minnesota-based primary care medical groups located in the Minneapolis/St. Paul metropolitan region. Patients were attributed to medical groups based primary care use as determined by evaluation and management codes (i.e. E&M codes).(50) A group needed to account for more than 50% of a patient's primary care for him/her to be attributed to a medical group. Those with less than 50% attributable to a single group were excluded. The average proportion of office visits attributable to a primary medical group was 67.5%. In Minnesota, most physicians practice in relatively large medical groups, usually consisting of multiple clinic sites.

Data came from two sources. Practice system measures came from a medical director survey, the PPC-RS. Diabetes related outcomes, patient demographics and diabetes-related costs came from health plan administrative databases. The study was reviewed, approved, and monitored by the HealthPartners Institutional Review Board.

Measure of PCMH- The PPC-RS—Using the framework of the Chronic Care Model and the PCMH(51), the Physician Practice Connections Readiness Survey (PPC-RS) is a tested and validated survey that measures the presence of clinical practice systems (Table 1) and forms the basis of the PPC-PCMH instrument used in NCQA qualification of practices as PCMH's.(37, 52, 53) It was completed by medical group medical directors in the summer of 2005. A full description of the tool as well as a crosswalk of the PPC-RS and the PPC-PCMH is available on request from one of the authors.

HealthPartners (HP) Administrative Data—HealthPartners administrative databases contain information regarding medical diagnoses and care, pharmacy fills, utilization, and costs. The total number of fills of outpatient pharmaceutical scripts by drug class was grouped into four categories: Glucose Lowering, Hypertension Control, Cholesterol Lowering, and Other. Some patients (148) did not have full prescription data due to payer mix (i.e. dual payer or pharmacy carve-out). These data were imputed using multiple regressions.(54–56) Quality diabetes care was defined by: glycated hemoglobin (A1c)< 8%, systolic blood pressure (SBP)<130 mm Hg, and low-density lipoprotein (LDL) measure<100 mg/dl.

Our cost outcomes are based upon a standardized measure of utilization, the HealthPartners Relative Resource Value (HPRRV).(57–64) HPRRVs are based upon Centers for Medicare and Medicaid Services (CMS) relative value units (RVUs) but extend RVU measures to

include inpatient, outpatient surgery, emergency room services, scheduled outpatient, professional, and pharmacy services. Where a CMS weight does not exist, HPRRVs use the average billed amount from HealthPartners claims. Because HPRRVs value services similarly to RVUs, HPRRVs are convertable to dollars using the Medicare cost factor for the study year (i.e. 100 HPRRVs $106).

Claims data were organized using Episode Symmetry (ESE) software.(65) For acute events, the ESE algorithm constructs episode treatment groups (ETGs) based upon serially occurring CPT and ICD codes. For chronic diseases like diabetes, the ESE algorithm groups all related E&M, ICD and CPT codes (lipid panels, insulin, emergency department visits, hospitalizations, etc.) occurring within a pre-defined time-window of 12 months. Utilization more closely associated with other conditions or triggered by acute events is allocated to separate ETGs.

Study Outcomes—This study focused on three outcomes: 1) total cost of care, 2) ambulatory management costs, and 3) potentially avoidable costs (disease-related unplanned hospital stays or emergency department use). A patient's total cost of care was defined as all diabetes-related costs occurring during the episode. Ambulatory management costs were defined as all discretionary healthcare resources attributable to primary care and management such as: a) claims from primary and specialty care services (clinic visit, scheduled radiographic procedures, labs performed on a outpatient bases, and outpatient prescriptions), and b) claims for scheduled inpatient procedures (surgical fees, hospital professional fees, and inpatient hospital costs). Potentially avoidable costs were utilization that the use of systems and the PCMH is intended to reduce. These are: a) service claims for emergency care attributable to diabetes (emergency transport charges, urgent care fees, emergency physician professional fees, imaging or lab charges), and b) hospital and other facility fees corresponding to that emergency care (unscheduled surgery, facility costs corresponding to an unscheduled inpatient stay, and transitional/step-down care).

Final Sample—We identified 2,183 patients with Type 2 diabetes who receiving over 50% of their primary care from a contracted medical group completing the PPC-RS. Of these, 175 were associated with a medical group whose PPC-RS responses were incomplete. This resulted in 2,008 patients from 27 medical groups in the final sample (Tables 1 and 2).

Plan of Analysis

We followed a bottom-up approach. First, we tested for significant variation at the medical group level using a likelihood ratio test set at the 5% level. Second, we constructed a baseline patient-level model. Covariates significant at the 10% level in univariate models were candidates for the multivariate model. Candidate covariates were screened for confounding and multicolinearity prior to development of the final multivariate model and appropriate adjustments taken. Covariates and interactions significant at the 10% and 5% level were retained, respectively. Third, PPC-RS systems scores were analyzed. Each domain score (*Health Care Organization, Delivery System Redesign, Clinical Information System, Decision Support, and Self Management Support*) and the overall PPC-RS score were considered in a separate models. Cross-level interactions with patient-level factors

significant at the 5% level were retained. Finally, a model incorporating all of the domain scores was fit.

Preliminary analysis indicated no significant proportion of the overall variation was attributed to medical group (ICC 0). Further, a generalized linear model with gamma-distributed errors was found preferable to a log-transformed model.(66–70) To protect against heteroskedasticity, a robust covariance estimator was used.

Because only 781 (39%) of the included patients had potentially avoidable resource use, a two-part model was used. The first part estimated the likelihood of any utilization using a multivariate, logistic regression. The second modeled avoidable resource use among those with utilization. Our final cost estimates were derived by conditioning estimated costs effects upon estimated likelihood of any utilization.

Results

Table 2 provides information on the demographics, clinical characteristics, and utilization for our analytic sample. Subjects averaged 54 years, 42% were female, and the mean BMI=34.4 Kg/m2 (SD 7.6). Most had at lease one comorbid condition with hypertension (54%) being the most prevalent.

Costs, including pharmaceutical use, varied widely. Total costs averaged $4,137, and were heavily skewed with a range from $305 to $73,029. Most (61%) had no potentially avoidable costs, and there was variation among those who did (range = $47.07 to $63,752.54).

The 27 medical groups varied in terms of their patient demographics and clinical practice system scores (Table 3). The average number of patients was 63 (range=8 to 179). The medical group median total per patient cost averaged $3,243 (range $2,091 to $4,768). Median per patient ambulatory management costs were less variable (mean $2,641, SD= $531). The level of clinical practice systems implementation varied considerably. Overall PPC-RS system scores ranged from 32.2 to 95.8 with an average of 67.9.

Table 4 shows the cost relations between clinical practice systems and annual diabetes-related costs. Although overall PPC-RS scores were associated with an apparent decrease in total, ambulatory, and potentially avoidable costs, none of these associations were statistically significant at the 5% level. The health care organization (HCO) domain score was not significantly associated with ambulatory management costs (p=.25); however, it was significantly associated with decreased potentially avoidable costs and total costs. A 10% increase in an HCO score (from 86 to 95) was associated with both a decreased likelihood (OR=.97, p=.04) and decreased amount (p=.04) of potentially avoidable costs for estimated overall per person decrease of $25.20.

A clearer understanding this association comes from examining individual elements of the PPC-RS (Table 1). The HCO domain is composed of three questions: Formal Quality Improvement Activities (QI), Performance Measurement (PM), and Individual Feedback (IF). Only one medical group failed to engage in any activities, while three engaged in only

formal QI activities. One engaged in both QI and PM and the remaining 22 medical groups engaged in all three. After adjusting for patient age, gender, co-morbidities, smoking status, A1c level, LDL level, and prescription drug use, patients at the medical group with no QI activities averaged $125 *more* per patient than those at the three medical groups with only formal QI activities. Patients at medical groups with both QI and PM averaged $126 *less* than those at the three medical groups with only formal QI activities, and patients at the medical groups with all three HCO activities (QI, PM, and IF) averaged $245 *less* than patients at the three medical groups with only QI. In other words if the five medical groups that currently do not began to engage in all three HCO activities there could be an estimated overall cost reduction of $53,721, or 5% of the total costs incurred by the 275 patients within these five medical groups.

A similar relationship was observed with *Decision Support*. Patients who received care at medical groups with improved decision support had a significantly lower likelihood of incurring any potentially avoidable costs (OR= .94, p=.02) with no change in the average amount of avoidable costs (p =.86). This resulted in a net average marginal cost reduction of $26 for every 10% increase in a medical group's decision support score. Although a seemingly small amount, individual components provide a clearer illustration of this association. Nine components comprise the *Decision Support* domain score (Table 1). All 27 medical groups have implemented age-appropriate preventive services and all but one has implemented evidence-based diabetes standards. The groups differ in the implementation of clinical reminders, alerts, and abnormal test protocols. After adjusting for age, gender, co-morbidities, and pharmaceutical use, only clinical reminders for counseling had a significant cost association (p=.01) with the 18 medical groups (1,429 patients) with counseling reminders averaging $337.93 per patient less than the 9 medical groups (579 patients) without this decision support system.

Discussion

This cross-sectional study suggests some office practice systems associated with the PCMH may moderate health care costs. Patients were less likely to have potentially avoidable costs such as emergency care and unscheduled hospital stays and were more likely to have lower overall costs when they received care from medical groups that had implemented PCMH-related systems in their practices such as formal quality improvement initiatives, individualized feedback, and clinician reminders.

However, we did not find a significant cost relationship between the implementation of systems and cost related to the direct management of diabetes in the clinic setting (Ambulatory Management Costs-Table 4). This is not surprising because implementation of systems in domains such as Delivery System Redesign, Clinical Information Systems, and Decision Support may be expected to *increase utilization* of some direct care resources (e.g. medication use or care management) in the short run (i.e. the one year period studied). Although higher delivery system redesign scores were significantly associated with increased ambulatory management costs (p=.01), the estimated monetary impact was small ($.99/patient/year).

Prior studies that have attempted to correlate system use with medical costs are scarce. Studies by Gillies et al(71), and others(37, 52) have shown a relationship between quality and use of systems using a related instrument. An interesting set of related findings was reported in a recent paper by Scholle(72), indicating a negative relationship between quality of care using HEDIS quality measures in diabetes and resource use measures of total utilization of inpatient, surgical and procedures by the same patients at the health plan level. By contrast, a positive relationship was noted between quality of care and use of pharmacy resources in the same cohort of patients with diabetes.

These findings are preliminary, since they are based on a relatively small and limited sample of medical groups drawn from a single geographic region with a long- term emphasis upon improving diabetes care with results that are better than most other regions. In addition, the data are based only on insured patients and most of these medical groups have already achieved a significant level of PCMH clinical practice system implementation, so there is less variation in both factors being tested.

The cross-sectional design of the study prevents analysis of the potential impact of primary care medical home systems over time. Future studies are needed to determine the longitudinal impact of system redesign upon utilization and quality in a larger set of medical groups having greater variation in both systems and quality. Further, the study relied on medical directors' self-reports of the presence of clinical practice systems. Previous studies of the validation of this survey showed that medical directors were more likely to under-report systems in this community than to over-report them, at least when there was no financial incentive for the latter.[cites] Finally, there are many factors that can confound chronic disease care. We attempted to control for these by incorporating a variety of covariates in our final models such as age, gender, comorbidities, and pharmaceutical drug use. Nonetheless, this set of demographics was far from exhaustive, and we were unable to account for the impact of such factors as race and socio-economic status.

The study's findings regarding the impact of PCMH clinical practice systems upon costs may be conservative for other reasons. First, we examined costs directly attributable to diabetes. Most adults with diabetes have other chronic conditions that add substantially to their health care costs, and systems focused upon improving diabetes care are likely to also assist in managing these conditions.(51, 73) Additional research exploring whether improved clinical systems for one chronic disease assist in managing complex cases and further reduce total costs is needed.

Despite these limitations, these results raise a question about how much the implementation of the PCMH model could reduce the medical costs over which physicians may have the greatest direct control and benefit. The greatest opportunity for savings appears to be in potentially avoidable costs caused by unplanned hospitalizations and emergency department use. An inference building on this study, as well as prior studies linking broader use of systems with higher quality of care in diabetes is that the reduction in potentially avoidable costs is an indirect result of better ambulatory care management. The relationship between systems, quality and cost is far from simple and the current pioneering study provides only a starting point for more extensive and prospective evaluations of these interrelationships. We

suggest that planned medical home demonstrations should consider these possible competing cost patterns and relationships in their design and evaluation.

Conclusions

Some clinical practice systems appear to be associated with lower use of potentially avoidable care such as unplanned hospitalizations and emergency room visits. Efforts to promote and evaluate systematic care through the adoption of the Chronic Care Model and the Patient Centered Medical Home should include a controlled longitudinal evaluation of how these models of care are related to costs for managing chronic and preventive care as well as for costs for unexpected care such as unplanned hospitalizations and emergency visits.

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Table 1

Elements of the PPC-RS by Domain of the Chronic Care Model

Chronic Care Model Domain	Elements of the PPC-RS
Health Care Organization	Individual Feedback
	Performance Measurement
	Formal Quality Improvement Activities
Delivery System Redesign	Advanced Access
	Primary Care Teams
	Scheduling System for Physician Continuity
	Non-MD Educator
	Nurse Manager
	Pre-Visit Planning
	After Visit Follow-up
	Missed Appointments Follow-up
Clinical Information Systems	Disease Registry
	Problem Lists
	Medication Lists
	Process Flow Sheets
	Checklists of Tests or Interventions
	Patient Assessment Questionnaire
	Clinical Test Tracking
	Referral Tracking
	Electronic Medical Record
Decision Support	Clinical Guidelines
	Clinical Guidelines Preventive Services
	Clinician Reminders for Diabetes Care
	Clinician Reminders for Preventive Services
	Clinician Reminders for Risk Assessments
	Clinician Reminders for Counseling
	Abnormal Test Alerts
	Abnormal Test Protocols
Self-Management Support	Patient Reminders for Diabetes Care
	Patient Reminders for Preventive Services
	Self Management Plans and Materials
	Self Management Programs
	Individualized Patient Education
	Electronic Patient Communication
	Risk Factor Screening

Table 2

Patient Demographics, Clinical Characteristics, and Utilization (N=2008)

	N	Mean (SD) or Percent
Demographics		
Patient Age	2008	54.1 (9.3)
Male		58
Clinical Characteristics		
Systolic BP	1965	126.3 (15.1)
A1c	1916	7.3 (1.5)
LDL	1825	97.5 (42.6)
BMI*	969	34.4 (7.6)
ASPIRIN USE (%)	2008	71%
Comorbidities		
CHF (%)	2008	23%
CVD (%)	2008	9%
ASTHMA (%)	2008	10%
COPD (%)	2008	5%
HTN (%)	2008	52%
Utilization (reported in HPRRVs)		
Ambulatory Management Costs	2008	$3,116 ($2,399)
Potentially Avoidable Costs[+]	781	$2,623 (4,763)
Total Costs	2008	$4,137 ($4,211)
Outpatient Pharmacy		
Number of Glucose Scripts	2008	11.3 (11.1)
% Generic[**]	1529	60% (39%)
Number of Hypertension Scripts	2008	10.2 (12.1)
% Generic[**]	1323	80% (33%)
Number of Cholesterol Scripts	2008	5.8 (6.91)
% Generic[**]	1212	12% (27%)
Number of Other Scripts	2008	18.98 (22.42)
% Generic[**]	1687	47% (32%)

[**] Among those with at least one Script

BMI= Body mass index

[+] Among 781 episodes with utilization

Table 3

Variation in Utilization and Systems Across Medical Groups (n=27)*

		Mean	Std Dev	Max	Min
	Number of Complete Episodes	63	39	179	8
Utilization*	Ambulatory Management Costs	$2,641	$2,577	$531	$4,299
	Potentially Avoidable Costs+	$1,524	$1,534	$428	$2,206
	% of Episodes with Utilization	39%	39%	12%	75%
	Total Costs	$3,242	$3,265	$544	$4,768
Demographics	Patient Age	55	2	59	50
	Patients with CHF (%)	2.3%	2.7%	12.5%	0.0%
	Patients with CVD (%)	8.1%	5.3%	25.0%	0.0%
	Patients with ASTHMA (%)	8.1%	4.7%	16.7%	0.0%
	Patients with COPD (%)	4.8%	3.7%	10.8%	0.0%
	Patients with HTN (%)	49.6%	11.8%	83.3%	25.0%
Outpatient Pharmacy	Number of Glucose Scripts**	12	2	15	4
	% Generic***	63.0%	20.6%	100.0%	0.0%
	Number of Hypertension Scripts**	12	4	23	6
	% Generic***	97.8%	8.5%	1.0%	55.0%
	Number of Cholesterol Scripts**	9	1	11	6
	% Generic***	0.0%	0.0%	0.0%	0.0%
	Number of Other Scripts**	16	5	33	6
	% Generic***	44.4%	11.3%	60.1%	12.1%
Performance	Patients at BP Goal (%)	56.3	11.0	72.0	20.0
	Patients at A1c Goal (%)	78.5	7.4	87.0	57.0
	Patients at LDL Goal (%)	63.0	11.3	87.0	41.0
	% at 2 or more Goals**	73.0	7.0	92.0	61.0
	% at 3 Goals**	32.3	8.2	48.0	16.7

		Mean	Std Dev	Max	Min
Practice Systems	Health Care Organization	86.6	22.4	100.0	25.0
	Delivery System Redesign	34.8	14.1	62.5	12.5
	Clinical Information System	48.8	16.9	85.7	14.3
	Decision Support	56.7	25.2	100.0	12.5
	Self-Management Systems	67.9	20.8	100.0	32.2
	Overall PPC System Score	67.9	15.8	95.8	32.2

* Based upon each medical group's median costs per annual episode.

** Denominator is total number of episodes for medical group

*** Among those with at least one script

+ Among the 781 episodes with utilization

Table 4

Regression Results: Association between Clinical Practice Systems (PPC-RS score) and Medical Costs*

Total Costs	**Coefficient**	**p-value**	**Marginal Impact upon Costs****
Health Care Organization	*−0.002*	*0.040*	*($31.33)*
Delivery System Redesign	−0.003	0.327	$29.15
Clinical Information System	−0.001	0.953	($6.97)
Decision Support	*−0.002*	*0.068*	*($30.46)*
Self-Management Systems	0.001	0.553	$16.62
Overall PPC System Score	−0.002	0.205	($27.39)

Ambulatory Management Costs	**Coefficient**	**p-value**	**Impact upon Costs****
Health Care Organization	*−0.001*	*0.251*	*($12.65)*
Delivery System Redesign	0.001	0.007	$1.05
Clinical Information System	−0.001	0.009	$0.37
Decision Support	*−0.001*	*0.967*	*($0.50)*
Self-Management Systems	0.001	0.600	$5.57
Overall PPC System Score	−0.003	0.983	($0.37)

	Likelihood of Use		**Resource Utilization**		
Potentially Avoidable Costs	**Coefficient**	**p-value**	**Coefficient**	**p-value**	**Marginal Impact upon Costs****
Health Care Organization	*−0.029*	*0.036*	*−0.019*	*0.037*	($25.20)
Delivery System Redesign	−0.002	0.490	0.011	0.080	$0.89
Clinical Information System	−0.002	0.523	−0.010	0.713	($14.06)
Decision Support	*−0.066*	*0.023*	*0.001*	*0.864*	($26.42)
Self-Management Systems	−0.001	0.690	0.001	0.655	$1.78
Overall PPC System Score	−0.006	0.153	−0.001	0.939	($26.10)

* Scaled by the average resource use in the sample and adjusting for Age, Age2, Gender, CHF, COPD, HTN, CVD, Asthma, Smoking Status, Daily Aspirin Use, A1c<8, LDL, and pharmaceutical use.

** Based upon a 10% increase in the system score above the sample average