Association of the Patient-Centered Medical Home Implementation with Chronic Disease Quality in Patients with Multimorbidity

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BACKGROUND: The patient-centered medical home (PCMH) was established in part to improve chronic disease management, yet evidence is limited for effects on patients with multimorbidity.

OBJECTIVE: To examine the association of Patient-Aligned Care Team (PACT) implementation, the Veterans Health Administration (VA) PCMH model, and care quality for multimorbid patients enrolled in VA primary care from 2012 to 2014.

DESIGN: Retrospective cohort.

PATIENTS: 318,764 multimorbid (≥ 3 chronic diseases) patients receiving care in 917 clinics.

MAIN MEASURES: PCMH implementation was measured using the PACT Implementation Progress Index (PI²) for clinics in 2012. The PI² is a validated composite measure of administrative and survey data with higher scores associated with greater care quality. Quality outcomes from 2013 to 2014 were assessed from External Peer Review Program (EPRP) metrics. Outcomes included preventative care, chronic disease management, and mental health and substance use metrics. We used generalized estimating equations to model associations adjusting for patient and clinic characteristics. We also examined associations for a subgroup with ≥ 5 chronic diseases.

KEY RESULTS: For one-third of metrics (5/15), greater implementation of PACT in 2012 was associated with higher predicted probability of meeting the quality metric in 2013–2014. This association persisted for only two metrics (diabetic glycemic control, $P < 0.001$; lipid control in ischemic heart disease, $P = 0.02$) among patients with ≥ 5 chronic diseases.

CONCLUSIONS: Multimorbid patients engaged in care from clinics with higher PCMH implementation received higher quality care across several quality domains, but this association was reduced in patients with ≥ 5 chronic diseases.

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INTRODUCTION

Patients with multiple chronic diseases, or multimorbidity, comprise over half of those age ≥ 65 .^{1, 2} Multimorbid patients are a vulnerable population, with worse health outcomes and higher mortality.^{3–5} Compared with those with fewer diagnoses, they interact with health systems differently. They have more face-to-face primary care visits—creating opportunities for screenings and disease monitoring.^{6, 7} At the same time, they have greater medical complexity and socioeconomic needs, which can lead to challenges for primary care providers (PCPs) balancing competing demands with chronic care needs.^{2, 8, 9}

The patient-centered medical home (PCMH) is based on the chronic care model, which provides a framework for understanding the care of chronic diseases.¹⁰ Despite relevance to multimorbid patients, effects of the PCMH for these patients are uncertain. In 2010, the Veterans Health Administration (VA) began implementing a PCMH model, the Patient-Aligned Care Team (PACT) initiative, in over 900 primary care clinics nationwide. The PACT model focused on chronic disease management, expanded access and continuity, comprehensive care through population-based screenings and disease registries, and patient-centeredness through staff training and care redesign.¹¹ Patients within PACT are assigned to “teamlets” with a core of a primary care provider (PCP) and nurse care manager. Teamlets belong to larger teams with interdisciplinary support staff, including integrated behavioral health. Despite organizational similarity, PACT was not implemented uniformly at all sites. In observational studies, clinics with greater PACT implementation delivered better quality care, had lower preventable hospitalization rates for patients, and higher patient satisfaction.^{12, 13}

Despite promising findings within the VA overall, the potential impact of PACT on multimorbid patients is less clear. Within PACT, increased attention on chronic disease management could result in conflicting therapies (e.g., NSAIDs with osteoarthritis and hypertension) or unsustainable drug regimens for patients eligible for multiple disease guidelines.^{14, 15} Alternatively, comprehensive screenings could have widespread ripple effects, such as the consequences of detecting and treating depression for patient engagement in care.¹⁶ Understanding the effect of PACT implementation specifically for multimorbid patients could inform resource distribution and identify gaps in care processes critical for this high-risk group. To address this, we examined quality metrics for preventative care and chronic disease management across a national sample of multimorbid patients receiving care from the VA.

METHODS

Study Overview and Data Sources

We performed a retrospective cohort study examining the association of a clinic-level measure of PACT implementation in 2012 with quality outcomes in 2013–2014. We selected these years to fall after the national rollout of PACT, yet prior to community care expansion in the Choice Act of 2014.¹⁷ Quality outcomes were from the VA's External Peer Review Program (EPRP) database. Provider and clinic data were from the VA Provider Specialty Workforce Report and VA Site Tracking System. Patient characteristics and utilization were from the VA Corporate Data Warehouse.¹⁸ Rural status was per the US Census Bureau. This study was part of the VA's PACT evaluation and considered quality improvement rather than research, and was therefore not subject to institutional review board approval or waiver.

Cohort Description

We identified 450,019 Veterans enrolled in the VA in fiscal year (FY) 2012 (10/1/11–9/30/12), with a quality metric measured in late FY2013 through FY2014 (4/1/13–10/30/14). Patients were excluded if they were not seen in a primary care clinic in 2012 ($n = 13,091$, 2.9%), were missing covariates ($n = 4850$, 1.1%), or were not multimorbid ($n = 112,847$, 25.1%). Multimorbidity was defined as ≥ 3 chronic diseases in ≥ 3 body systems based on encounter diagnosis codes during FY2012. Diseases and body systems were categorized using ICD-9 codes according to the Agency for Healthcare Research and Quality's Chronic Condition Index.^{1, 19} Our final cohort included 318,764 patients.

Quality Outcomes

Previous observational studies have examined the relationship between PACT implementation and quality metrics for 48 available EPRP metrics relating to chronic disease

management, mental health and substance use disorder screening, and preventative care.^{13, 20} We drew from conceptual frameworks to determine which metrics were chosen and develop our understanding of complexity within multimorbid patients.^{8–10} From this list of 48 metrics, we selected 16 metrics a priori that best represented how the medical home might affect quality metrics for multimorbid patients and/or be mediated by patient complexity through the domains of the PCMH, such as increased screenings through team-based care and chronic disease management, and/or be mediated by patient complexity, such as potential clinical tradeoffs in care needs. We excluded metrics that could be potentially inappropriate for patients with reduced life expectancy or increased disease burden (such as malignancy screening) and metrics related to actions not directly performed by the PACT team (such as teleretinopathy screening for diabetics). We selected 16 metrics for high-prevalence chronic diseases in the VA (diabetes, cardiovascular disease, mental health, substance use disorders),²¹ and vaccines to represent non-disease or gender-specific preventative care processes broadly applicable to multimorbid patients. EPRP metrics are analogous to other national quality performance metrics used outside the VA (such as HEDIS measures). They are abstracted from charts by an independent group from a stratified random sample of outpatients seen in the past month, with oversampling among patients with chronic conditions.²² Patients are eligible independently for each metric and can be sampled once per metric per year. If selected more than 1 time for the same metric during the study period (as this spanned across 2 years), we used the first measurement. For this analysis, patients were permitted to be part of multiple denominators as outcomes were assessed independently.

PACT Implementation

Our primary independent variable was the level of PACT implementation at a patient's primary care clinic in 2012. The level of PACT implementation was measured using the previously validated PI² score, a composite of administrative and survey data capturing 8 PCMH domains: access; continuity; care coordination; comprehensiveness; self-management support; patient-centered care; shared decision-making; and team functioning.¹³ The extent to which clinics implemented each domain was measured with standardized z-scores. Total clinic scores were calculated as the number of domains within the top versus bottom quartiles, ranging from -8 (all domains in bottom quartile) to $+8$ (all domains in top quartile). We employed previous divisions for categories of PACT implementation ranging from low to high levels of implementation (-8 to -5 ; -4 to -2 ; -1 to 1 ; 2 to 4 ; 5 to 8).^{13, 20} Previous observational studies have shown that clinics measuring in the highest quartile for all domains had higher patient satisfaction with care by a full 1 point (on a 10 point scale), lower staff burnout by 0.5 points on the Maslach Burnout Inventory, 57 fewer emergency department visits and 6 fewer

hospitalizations per 1000 patients compared with those clinics in the bottom quartile for all domains.¹³

Covariates

We adjusted for potential confounders from 2012 consistent with prior studies.^{13, 20} These included patient characteristics (age, sex, race/ethnicity, copay exemption, marital status, median household income by residence county, travel distance to clinic), and clinic characteristics (full time equivalent PCPs per 10,000 patients, location (urban vs. rural), hospital or community affiliation), and a time variable for quarter of sampling year.

Statistical Analyses

We performed descriptive analyses separately to characterize the overall cohort and patients within each metric. In these analyses, we compared characteristics of patients receiving care at the top versus bottom quintile of PACT implementation clinics using unequal variance *t* tests or Pearson's chi-square tests as appropriate. We used generalized estimating equations (GEE) with a logit link to estimate associations between PI² quintile and dichotomous quality metrics, adjusting for covariates. We assumed an exchangeable correlation working structure to accommodate increased correspondence of outcomes within the same clinic. We converted coefficients to predicted probabilities assuming unbalanced data. We used ANOVA for tests of trend. Standard errors were heteroskedastic robust with two-sided hypothesis testing and an alpha of 0.05. Analyses were conducted using R 3.5.0 (www.r-project.org) and Stata 14.0 (StataCorp, 2015, College Station, TX).

We performed several secondary analyses. First, as an effect modifier, we examined the interaction of prior hospitalizations in 2012 with PACT implementation. We selected hospitalizations as a marker of illness severity that could potentially indicate differential care receipt (for example, acute illnesses that would be prioritized over vaccination).²³ Next, we examined the interaction of total primary care visits during 2012 and PACT implementation to determine if the "dose" of PACT exposure was important. If the interaction term for the effect modifier and the predictor was significant using ANOVA, we then conducted joint tests of the predicted probability of outcomes between groups differing across levels of effect modifier (that is, comparing patients with and without prior hospitalizations, across a clinic PI² category) to assess effect size differences. In addition to these effect modifier analyses, we performed a sensitivity analyses using only those clinics with a minimum of ≥ 5 patients to assess for influence of statistical "noise" from low volumes. Finally, to approximate effects for complexity, we examined effects for patients with ≥ 5 chronic diseases in ≥ 5 body systems ($n = 180,672$).^{24–26}

RESULTS

Patients with multimorbidity were the majority (70%) of those engaged in care in 2012 who also had quality metrics available in 2013–2014 (Fig. 1). Patients receiving care from top performing clinics for PACT implementation were older (65 vs. 64 years), more male (88% vs. 86%), non-Hispanic White (80% vs. 68%), and seen more in rural (41% vs. 25%) and community clinics (63% vs. 51%), compared with patients in the lowest performing clinics (all $P < 0.001$, Table 1).

After covariate adjustment, there was a significant trend for 5 of 15 quality metrics between greater implementation of PACT and higher probability of achieving the quality metric. These included glycemic control (trend, $P < 0.001$) and lipid control ($P = 0.04$) among diabetics; lipid control ($P < 0.01$) among ischemic heart disease (IHD) patients; influenza vaccination ≥ 65 years ($P = 0.02$); and timely follow-up of positive post-traumatic stress disorder (PTSD) screening ($P = 0.02$, Table 2). The overall difference in probability of meeting quality metrics between clinics with lowest to highest PACT implementation ranged from 2% (diabetic lipid control, 86.1% vs. 88.1%, as well as influenza vaccine ≥ 65 years, 78.1% vs. 80.1%) to 7.3% (PTSD screening follow-up, 78.1% vs. 85.4%). For the final of the 16 metrics (timely follow-up after positive depression screening, $n = 2209$), limited variation in the outcome across covariate levels precluded analysis and the metric was dropped. For more complex patients (those with ≥ 5 chronic diseases), greater PACT implementation was significantly associated with higher quality for only 2 of 15 metrics (diabetic glycemic control, $P < 0.001$; IHD lipid control, $P = 0.02$).

There was no difference in effect sizes across comparable categories of PACT implementation (i.e., no effect modification) for patients with a prior hospitalization in 2012 (Supplemental Table e1), nor a difference by total primary care visits in 2012. Including only clinics with ≥ 5 patients resulted in a similar pattern and effect sizes in quality metrics as the primary analysis, although an additional 2 metrics reached significance: influenza vaccination 18–64 years ($P = 0.03$) and timely follow-up after positive alcohol misuse screening ($P < 0.01$, Supplemental Tables e2–3).

DISCUSSION

Within a large cohort of multimorbid patients receiving care from VA primary care PACT teams from 2012 to 2014, we found that greater PACT implementation was associated with higher quality of care for 1 in 3 metrics. For more complex patients with ≥ 5 diseases, this association was less robust. This relationship was unchanged by severity of illness as measured by prior hospitalizations or by primary care visit frequency, and was relatively stable when low-volume clinics were excluded.

The link between medical homes and higher care quality is supported by other studies,^{12, 20, 27–29} but ours is among the

Fig. 1 Patients included in cohort of multimorbid Veterans engaged in primary care in 2012 with quality metrics measured in 2013–2014

first to examine this relationship for multimorbid patients within a large, integrated system. In prior observational work within VA primary care clinics for all patients regardless of disease burden, greater PACT implementation was associated with higher care quality for almost 40% of selected metrics.¹³ While fewer metrics were associated with PACT implementation in our multimorbid population, we did find significant associations for diabetic glycemic and lipid control that persisted even among high-complexity patients. This potential signal of lower quality care among multimorbid patients may reflect the “competing demands” that can occur for this population at the expense of longitudinal and preventative care,⁹ particularly for relatively “low-urgency” metrics like screenings. Those quality metrics representing longer-term care

processes, such as glycemic or lipid control, require a higher degree of patient self-management and engagement—suggesting mechanisms wherein high performing PACTs could influence care quality if successfully engaging multimorbid patients over time.^{30, 31}

For high-complexity patients, the PACT model may be insufficient to meet their extensive care needs. We found greater complexity (i.e., disease burden) was associated with reduced probability of meeting quality metrics. This is not surprising—prior studies show that even when services are intensified for complex patients, quality outcomes remain mixed, underscoring that even well-implemented PACTs may not be sufficient to deliver high-quality care for these patients.^{32, 33} The relationship between complexity and care

Table 1 Clinic and patient characteristics, overall and by quintile of clinic performance by Patient-Aligned Care Team Implementation Progress Index (PI²) score, 2012

	Overall, mean (SD)	Bottom category PI ²	Top category PI ²	SMD
Patients, no.	318,764	25,068	18,133	—
Age, years	64.8 (12.9)	63.8 (12.6)	65.4 (12.8)	0.1
Female, no. (%)	39,449 (12.4)	3389 (13.5)	2196 (12.1)	6.2
Race/ethnicity, no. (%)				—
Non-Hispanic White	237,141 (74.4)	17,079 (68.1)	14,525 (80.1)	40.5
Non-Hispanic Black	52,738 (16.5)	5550 (22.1)	2215 (12.2)	38.9
Hispanic	16,068 (5.0)	1206 (4.8)	706 (3.9)	6.5
Other	12,167 (3.8)	1182 (4.7)	659 (3.6)	8.1
Married, no. (%)	166,172 (52.1)	13,262 (52.9)	9623 (53.1)	0.5
Copay non-exempt, no. (%)	22,512 (7.1)	1377 (5.5)	1545 (8.5)	17.5
Median household income by county, 1 k USD	49.1 (12.1)	46.1 (10.2)	49.2 (11.8)	0.3
Distance to clinic, miles	45.0 (294.4)	54.3 (335.0)	37.8 (274.8)	0.1
Total chronic diagnoses*	5.1 (1.7)	4.9 (1.6)	5.1 (1.7)	0.1
Hypertension, no. (%)	231,197 (72.5)	18,436 (73.5)	13,160 (72.6)	3.2
Diabetes, no. (%)	134,118 (42.1)	10,615 (42.3)	7728 (42.6)	0.8
Depression, no. (%)	131,297 (41.2)	10,843 (43.3)	7344 (40.5)	8.2
Ischemic heart disease, no. (%)	87,760 (27.5)	6342 (25.3)	5193 (28.6)	11.1
Alcohol use disorder, no. (%)	35,780 (11.2)	2542 (10.1)	2062 (11.4)	5.8
Chronic heart failure, no. (%)	33,145 (10.4)	2418 (9.7)	1798 (9.9)	1.3
Clinic visits*				—
Primary care	5.8 (5.3)	5.7 (5.1)	6.1 (5.4)	0.1
Specialty care	2.0 (3.9)	1.8 (3.5)	2.0 (3.6)	0.1
Mental health	6.0 (16.7)	5.1 (14.0)	6.0 (17.2)	0.1
All-cause VA hospitalizations*	0.3 (1.0)	0.3 (0.9)	0.3 (0.9)	0.0
Clinics, total*	917	87	83	—
Patients seen in rural clinic, no. (%)	61,491 (19.2)	6192 (24.7)	7456 (41.1)	52.1
Patients seen in CBOC, no. (%) [‡]	148,164 (46.5)	12,799 (51.1)	11,341 (62.5)	41.8
Primary care providers per 10 k patients	13.1 (1.9)	12.8 (1.5)	13.4 (1.7)	0.4

Mean (SD), except where otherwise indicated. SMD, standardized mean difference as bias-corrected effect size.

*Not included as covariate in models.

[‡]Community-based outpatient clinic

quality is nuanced. Previously established relationships between disease groupings and care quality^{7, 34} show that quality of care may be contingent on which disease combinations occur among patients.³⁵ Patients and PCPs may also not agree about care priorities in the presence of higher disease burdens

or non-illness-related demands,³⁶ which in turn could affect achievement of longitudinal care goals and related quality metrics. Finally, while EPRP sampling is restricted to those with sufficient life expectancy, some metrics may still inadequately exclude frail and complex patients, lowering validity

Table 2 Predicted probability (95% confidence interval) of meeting quality metric for patients seen in primary care clinics, by category of Patient-Aligned Care Team Progress Implementation Index (PI²)

Metric	N	PI ² – 5 to – 7	PI ² – 4 to – 2	PI ² – 1 to 1	PI ² 2 to 4	PI ² 5 to 8	P*
CHF ACE [†]	3486	89 (85–93)	88 (85–91)	87 (86–89)	89 (86–92)	84 (78–90)	0.49
Diabetes							
A ₁ C < 9%	59,852	80 (78–81)	81 (80–82)	82 (82–83)	82 (81–83)	83 (81–84)	< 0.001
Foot exam	67,320	88 (85–90)	87 (86–88)	88 (88–89)	88 (86–89)	90 (88–92)	0.10
LDL < 100	59,826	86 (85–87)	87 (86–88)	88 (87–88)	88 (87–89)	88 (87–89)	0.04
BP < 140/90	59,852	78 (77–80)	78 (77–79)	79 (79–80)	79 (78–80)	80 (78–81)	0.34
IHD LDL [‡]	40,202	69 (67–71)	70 (68–71)	71 (70–72)	72 (71–74)	72 (70–74)	< 0.01
HTN < 140/90 [§]	126,364	77 (76–78)	77 (76–78)	77 (77–78)	78 (77–79)	79 (77–80)	0.32
Vaccines							
18–64 years flu	27,481	64 (62–66)	64 (63–66)	64 (63–65)	67 (65–68)	66 (63–68)	0.05
≥ 6 years flu	43,508	78 (76–80)	78 (77–79)	77 (76–78)	79 (78–80)	80 (78–82)	0.02
≥ 65 years PPSV23	79,102	93 (92–94)	93 (93–94)	93 (93–94)	94 (93–94)	93 (92–94)	0.06
Alcohol use							
Screening	185,447	64 (62–66)	64 (63–66)	64 (63–65)	67 (65–68)	66 (63–68)	0.19
Screen f/u	7946	78 (76–80)	78 (77–79)	77 (76–78)	79 (78–80)	80 (78–82)	0.06
Depression							
Screening	115,002	96 (96–97)	96 (96–97)	96 (96–96)	96 (96–97)	97 (96–97)	0.23
PTSD							
Screening	141,274	99 (99–99)	99 (98–99)	99 (99–99)	99 (99–99)	99 (99–99)	0.74
Screen f/u	3213	78 (72–84)	85 (82–88)	85 (83–91)	88 (84–91)	85 (80–91)	0.02

Models adjusted for patient characteristics (age, sex, race/ethnicity, copay exemption, marital status, median household income by county, and travel distance to clinic), and facility characteristics (full time providers/10,000 patients, rural or urban location, and hospital or community-based affiliation).

*P value for trend across categories of PI², in ANOVA. [†]Congestive heart failure patients with left ventricular ejection fraction < 40%, on ACE inhibitor or ARB. [‡]Ischemic heart disease patients with low-density lipoprotein under 100 or on moderate-dose statin. [§]Hypertensive patients with blood pressure ≤ 140/90 mmHg. ^{||}Positive screening with follow-up disposition in 24 h

of these measures as a way to capture quality of care.³⁷ These factors underscore that for complex patients, some of the benefits of the PCMH may be better represented by universal outcomes such as health-related quality of life.^{14, 38, 39}

Our study has limitations. First, we used administrative data for defining multimorbidity. Diagnosis codes not reflecting true pathology differences between patients could lead to difficulty distinguishing multimorbid and general PACT patients.⁴⁰ However, our findings were consistent as our specificity of multimorbidity definition increased, and there is little impetus to “up-code” diagnoses within integrated systems. Secondly, we note some baseline differences in patients receiving care from high and low PACT implementation clinics. Despite attempts to control for confounding, unobserved factors may influence our findings. Additionally, as we did not correct for multiple outcomes given lack of expectation of a type I versus type II error, we recognize the possibility that some of our findings may be due to statistical chance.^{41, 42} Our study was also limited to VA data. As those with the greatest medical needs are more likely to use services under both VA and Medicare,^{43, 44} our subgroup findings could be explained by high-complexity patients receiving care outside the VA. We did not assess the influence that disease “concordance” or similarity may have on the quality of care. Although we attempted to capture a definition of multimorbidity greater than simple disease counts by including a requirement of crossing body systems, the degree to which diagnoses share common treatment goals may influence measures of quality.⁴⁵

In conclusion, we found that greater implementation of the medical home model within a large integrated health system was associated with higher probability of meeting several quality metrics for a national cohort of multimorbid patients. This finding was tempered by patient disease burden, but not prior utilization. This adds to the evidence of the overall benefits of the PCMH model, but suggests that patient complexity may be an important arbiter of care quality as measured by current quality metrics. Finally, our findings emphasize the need to capture the more meaningful measures of care quality for complex multimorbid patients.

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Compliance with Ethical Standards:

Conflict of Interest: The authors have no additional conflicts of interest, financial or otherwise, to disclose.

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