

HEALTH POLICY

Pennsylvania's Medical Home Initiative: Reductions in Healthcare Utilization and Cost Among Medicaid Patients with Medical and Psychiatric Comorbidities

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BACKGROUND: The Chronic Care Initiative (CCI) was a large state-wide patient-centered medical home (PCMH) initiative in Pennsylvania in place from 2008–2011.

OBJECTIVE: Determine whether the CCI impacted the utilization and costs for Medicaid patients with chronic medical conditions and comorbid psychiatric or substance use disorders.

DESIGN: Analysis of Medicaid claims using difference-in-difference regression analyses to compare changes in utilization and costs for patients treated at CCI practices to propensity score-matched patients treated at comparison non-CCI practices.

SETTING: Ninety-six CCI practices in Pennsylvania and 60 non-CCI practices during the same time period.

PARTICIPANTS: A total of 11,105 comorbid Medicaid patients treated in CCI practices and an equal number of propensity-matched comparison patients treated in non-CCI practices.

MEASUREMENTS: Changes in total per-patient costs from 1 year prior to 1 year following an index episode period. Secondary outcomes included utilization and costs for emergency department (ED), inpatient, and outpatient services.

RESULTS: The CCI group experienced an average adjusted total cost savings of \$4145.28 per patient per year ($P=0.023$) for the CCI relative to the non-CCI group. This was largely driven by a \$3521.15 savings ($P=0.046$) in inpatient medical costs, in addition to relative savings in outpatient psychiatric (\$21.54, $P<0.001$) and substance abuse service costs (\$16.42, $P=0.013$), compared to the non-CCI group. The CCI group, related to the non-CCI group, had decreases in expected mean counts of ED visits (for those who had any) and psychiatric hospitalizations of 15.6 (95% CI: -21, -9) and 40.7 (95% CI: -57, -18) percentage points respectively.

LIMITATIONS: We do not measure quality of care and cannot make conclusions about the overall cost-effectiveness or long-term effects of the CCI.

CONCLUSIONS: The CCI was associated with substantial cost savings, attributable primarily to reduced inpatient costs, among a high-risk group of Medicaid patients, who may disproportionately benefit from care management in patient-centered medical homes.

KEY WORDS: Pennsylvania Chronic Care Initiative; Patient-Centered Medical Homes; Behavioral Health Integration; Medicaid Utilization and Costs; Health Care Reform; Physical and Mental Health Co-morbidities.

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BACKGROUND

The Patient-Centered Medical Home (PCMH) has flourished under the Affordable Care Act, which encourages its adoption through various provisions.^{1–3} Core elements of a PCMH include coordinated care, enhanced access, electronic health records (EHR), quality measures, and value-based payment.^{4–6} Among the many multi-payer PCMH experiments, Pennsylvania's 2008–2011 Chronic Care Initiative (CCI), was one of the largest.⁷ Practice participation was voluntary; patients were those already in the participating practices.^{8,9} With multi-stakeholder engagement, the state provided most of the leadership, financially supporting practice transformation while requiring practices to attend learning sessions, report monthly quality metrics, and use assigned practice coaches. The CCI was implemented incrementally, beginning with the southeast region in 2008, ultimately including 783 providers and serving over 1.18 million patients.¹⁰ Building on Wagner's Chronic Care Model,¹¹ CCI sites received behavioral health training and integrated depression screening, and they were coached to ensure coordination of behavioral and medical care.

A great deal of attention has focused on this natural experiment. An evaluation of the first 32 CCI practices in southeast Pennsylvania¹² found minimal improvements in quality and no cost savings. The study was criticized as missing the full impact of the program,^{13–15} which rolled out in other regions from 2009–2011, making improvements over time.¹⁶ Initially focusing on use of EHR and PCMH certification, the CCI later placed more emphasis on care management for high-risk patients.¹⁶ A follow-up study on 27 CCI practices and 29 comparison practices in the northeast region of Pennsylvania

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found that the CCI was associated with relative improvements in quality, increased primary care utilization, and lower use of emergency department, hospital, and specialty care.¹⁷ Recent claims analyses from private insurers also found significant reductions in ED use¹⁸ and overall reduced cost and hospitalization, but only among patients with chronic conditions.¹⁹

Our study adds to the literature with several strengths. First, we address CCI practices in the majority of the state rather than a subset of practices in single regions. Second, we focus on a high-risk group: continuously enrolled Medicaid patients with medical and mental health comorbidities, a unique subpopulation, which may disproportionately benefit from the structural benefits of care coordination.^{20,21} Third, we utilize a robust control group with propensity matching at the patient level and clustering at the practice level.

As eligibility for Medicaid expands across the country and new Medicaid payment incentives target PCMH services for enrollees with at least two chronic conditions,^{1,2} generating rigorous data on the financial impact of the PCMH model becomes even more critical as more patient care is delivered in these settings.

METHODS

We compared pre-post health care utilization and costs of Medicaid patients with at least one of four chronic medical conditions and psychiatric and/or substance abuse disorders treated in a CCI practice to a 1:1 propensity-matched sample of patients treated in non-CCI comparison practices across Pennsylvania using Medicaid claims. This study was approved by the University of Pennsylvania institutional review board with a waiver of informed consent.

Data

We obtained a list of 147 CCI practices from the Pennsylvania Department of Health. After contacting each practice, we excluded ten that did not serve Medicaid. A final set of 96 practices was selected in our propensity score matching because the smaller number of comparable non-CCI practices limited inclusion of all potential patients. Using Medicaid eligibility records, medical and pharmacy claims, and both Medicaid managed care encounters and fee-for-service claims from the Pennsylvania Department of Public Welfare from January 2005–June 2010, we identified patients with one or more primary or secondary diagnostic codes for each chronic medical condition (in any type of claim) and at least one claim (outpatient or inpatient non-laboratory claim) for a psychiatric and/or substance abuse disorder in that time period (see Table 2 for ICD-9 codes). The targeted conditions diabetes, chronic obstructive pulmonary disease, asthma, and heart failure were identified as imposing disproportionate health and financial burdens by the Pennsylvania Health Care Cost Containment Council.²² Comorbid behavioral health conditions included psychiatric (major depressive disorder, schizophrenia/

schizoaffective disorder, bipolar disorder, post-traumatic stress disorder, anxiety disorders) and substance use disorders (opioid, cocaine, alcohol).

Similar to prior CCI studies,^{12,17} we used comparison practices identified as having the same approximate composition in practice size, specialty (pediatrics, family practice, internal medicine), location (urban, suburban), and health system affiliation. There were no comparison practices identified from Northcentral or Northwest PA; however, the exclusion of these regions reduced the final pool of eligible Medicaid patients by only 1.5 %. Only 81 comparison practices treated Medicaid patients. During the propensity matching process, patients from 60 comparison practices both met our eligibility criteria during the target years and propensity matched with patients from the CCI practices. The CCI and comparison practices, respectively, were distributed across regions as follows: Southeast (40, 24), Southwest (19, 11), Northeast (25, 17), and Southcentral (12, 8).

Practices were defined based on site address in a provider database, confirmed by Internet/phone to assign providers to either a CCI or non-CCI practice. We identified “index episodes” for each patient, defined as the first claim after the date the patient’s practice joined the CCI for the CCI group and the first claim after commencement of the CCI program (matched for year and region) for the comparison group. Because the CCI was implemented in stages, we ensured that all index episodes for CCI patients occurred after their practice joined the CCI and had at least 12 months of continuous enrollment before and after. The index date represents the first exposure of each patient to the “intervention” of the CCI, which allowed for a pre-post comparison for each patient.^{23,24} We included dual-eligible patients in our sample, as many patients with chronic mental health and substance abuse conditions are in this category.

Costs were calculated using standardized prices for Medicaid claims; outpatient costs were standardized using the Medicaid outpatient fee schedule, regardless of fee-for-service or capitation (in Pennsylvania, even capitated Medicaid managed care plans are required to submit claims for provided services). Pharmacy costs were based on fee-for-service Medicaid pharmacy costs specified for each Hierarchical Ingredient Code. To standardize inpatient costs, we computed 2008 PA Medicaid average costs by Diagnosis Related Groups, using fee-for-service data.

Outcomes

We compared changes in the healthcare utilization and costs for patients treated at CCI practices to the utilization and costs for propensity-matched patients treated at non-CCI practices in the same year. We selected a 1-year post-index episode of care for both groups and compared the groups on change in utilization and costs (e.g., difference-in-difference) from the pre-index episode period to a 1-year post-index episode period. Healthcare utilization and cost variables were separated into ED, inpatient, and outpatient services and costs.

Sample Creation

Patients were attributed to the CCI group if they had at least one claim in a CCI practice. Patients were attributed to the non-CCI group if they had a claim in the specified comparison practices as long as they never had any claim in a CCI practice.

Propensity score matching was used to address the potential lack of comparability of patient groups in CCI practices and non-CCI practices at the time of treatment initiation. Table 2 provides the demographic and health condition matching variables included in the propensity scores, which were calculated using logistic regression to predict the probability that patients belonged in the CCI vs. non-CCI groups. Other matching variables were supplemental security income benefits (SSI), dual Medicaid/Medicare eligibility, year of index episode, region of the state, and average number of Medicaid patients in the practice. Once each patient was assigned a propensity score, patients in the CCI practices were matched, stratifying on medical condition with a pool of patients treated at a comparison non-CCI practice, following the nearest-neighbor 1:1 matching approach. CCI and non-CCI patients were matched only if the absolute difference in their propensity scores was within a prespecified maximal distance (the caliper distance), here defined as 0.2 standard deviation of the logit of the propensity score. Following the match, there was good balance across the groups on each variable, assessed through t-tests and chi-square tests, with the exception of a slight imbalance in the number of patients drawn from the respective regions. Because of this, region was included as a covariate in the main analyses. A total of 941 CCI patients were not selected in the match process because they were relatively more discrepant on the matching variables from the non-CCI patient. These lacks of matches were largely a function of a limited number of comparison practices to select non-CCI matches in some regions of Pennsylvania.

We included patients with claims for both chronic medical conditions and behavioral health diagnoses in the 2006–2010 time period. This included the post-index episode period in order to have the broadest generalizability and because these are chronic conditions that typically manifest first as sub-threshold symptoms that, if managed well, can be prevented from evolving into full diagnoses.

Statistical Analysis

The primary outcome was the difference in total costs between the 1-year post-index episode period and the 1-year pre-index episode period with secondary outcomes including specific ED and inpatient and outpatient cost variables. To account for non-normality, Box-Cox power transformations²⁵ were assessed through PROC TRANSREG within SAS 9.3.²⁶ Optimal transformation of the cost measures is indicated in Table 4. The primary analysis of the cost variables consisted of a mixed-effect model on the difference-in-difference scores, including practice as a clustering variable.

Health care utilization counts were analyzed with practice as a clustering variable using either a generalized Poisson (GP) model, negative binomial regression (NB) models, zero-inflated generalized Poisson model, or zero-inflated negative binomial models (ZINB) with PROC-GENMOD, PROC-GLIMMIX, and PROCNLMIXED.^{26,27} Choice between the zero-inflated models and non-inflated models depended on the magnitude of the zero counts, assessed through Vuong's test.²⁸ The choice between the generalized Poisson and negative binomial depended on underdispersion versus overdispersion. For the zero vs. non-zero component of the zero-inflated models, differences between the CCI and non-CCI groups were quantified through odds ratios (OR) with 95 % confidence intervals (CI). For the generalized Poisson, negative binomial regression, and count portion of the zero-inflated models, the exponential of the regression coefficient for the CCI versus non-CCI comparison was interpreted as the percent increase/decrease in the expected count for CCI compared to non-CCI.²⁹

Covariates included in all mixed-effect models and generalized linear models were region, pre-index year total cost at the patient level, pre-index year total utilization at the patient level, average pre-index year total cost per practice, average pre-index year total utilizations per practice, and pre-index year score.

A sensitivity analysis was conducted to evaluate whether the results would be similar if the entire sample of eligible patients from CCI practices ($n = 106$) and non-CCI practices ($n = 60$), within the target years, were examined (without propensity score matching). This sample was analyzed using baseline propensity scores, region, and total pre-index episode costs as covariates.

RESULTS

Characteristics of the Study Population

Table 1 shows the overall prevalence of our study's four chronic medical conditions and comorbid psychiatric/substance abuse disorders. Of these, propensity matching

Table 1 Characteristics of Pennsylvania's Medicaid Population between January 2008–June 2010

	% of All Medicaid enrollees	N
All Medicaid enrollees	100 %	2,838,310
Any of the 4 chronic medical conditions below	18.7 %	530,473
Congestive heart failure	2.2 %	61,527
Diabetes	7.0 %	197,822
Chronic obstructive pulmonary disease	4.4 %	125,643
Asthma	9.7 %	276,757
Any psychiatric or substance use disorder	29.0 %	823,873
Psychiatric disorders	25.4 %	722,070
Substance use disorders	8.9 %	252,934
Comorbid disorders ^a	7.8 %	220,919

^aComorbid disorders defined as at least one of the four chronic conditions above and at least 1 psychiatric or substance use disorder during the period 2008–2010 (continuous enrollment not required)

selected 11,105 Medicaid patients with at least one of the chronic medical conditions and a comorbid substance use or psychiatric disorder who were treated in CCI practices between January 2008–June 2010 and an equal number of matched patients treated by non-CCI providers in the same time frame. Note that although laboratory claims for the four chronic medical conditions were used in the selection of the sample, just 303 (1.4 %) of the 20,914 patients had only a laboratory claim for one of the chronic medical conditions.

Table 2 shows the characteristics of these patients following matching on propensity score demographic and health conditions variables, such as gender, race, age, comorbidity index, and proportion with a substance use or psychiatric disorder claim (any type of claim) in the 1 year prior to the index episode. Within this sample, 84.3 % in the CCI group and 82.9 % in the non-CCI group had at least one of the four medical diagnoses prior to the index episode. Excluding laboratory claims for the psychiatric/substance use disorders, the

Table 2 Characteristics of Sample and Propensity-Matched Controls

Patient characteristics	Propensity-matched control patients treated at non-CCI practices 2008–2010 ^a					Patients treated at CCI practices 2008–2010				
	CHF 1420	Diabetes 3742	COPD 3121	Asthma 7226	Total 11105	CHF 1420	Diabetes 3742	COPD 3121	Asthma 7226	Total 11105
Gender, n, (%) male	52,9 37.3 %	132,4 35.4 %	118,1 37.8 %	269,0 37.2 %	433,0 39.0 %	54,1 38.1 %	122,0 32.6 %	108,8 34.9 %	270,0 37.4 %	424,7 38.2 %
Race, n (%)										
White	48,9 34.4 %	133,2 35.6 %	144,9 46.4 %	240,9 33.3 %	398,3 35.9 %	51,4 36.2 %	149,2 39.9 %	156,3 50.1 %	233,9 32.4 %	408,5 36.8 %
African-American	76,2 53.7 %	184,5 49.3 %	132,1 42.3 %	380,6 52.7 %	564,5 50.8 %	81,8 57.6 %	190,1 50.8 %	132,1 42.3 %	37,00 51.2 %	552,6 49.8 %
Hispanic	131 9.2 %	46,6 12.5 %	275 8.8 %	87,6 12.1 %	122,2 11.0 %	58 4.1 %	240 6.4 %	168 5.4 %	95,4 13.2 %	114,5 10.3 %
Other	38 2.7 %	99 2.7 %	76 2.4 %	135 1.9 %	255 2.3 %	30 2.1 %	109 2.9 %	69 2.2 %	233 3.2 %	349 3.1 %
Age, M (SD)	52.1 (14.60)	47.2 (14.52)	45.9 (16.42)	26.9 (17.92)	34.0 (19.78)	52.4 (14.12)	47.3 (14.45)	47.0 (16.42)	26.7 (18.46)	34.2 (20.15)
Comorbidity Index ^b	2.9 (2.02)	2.3 (1.70)	2.2 (1.75)	1.2 (1.40)	1.5 (1.52)	2.8 (1.92)	2.3 (1.67)	2.2 (1.76)	1.2 (1.39)	1.5 (1.51)
Substance use disorder (any), n (%) ^c	34,1 24.0 %	83,4 22.3 %	93,8 30.1 %	124,2 17.2 %	222,3 20.0 %	34,7 24.4 %	85,4 22.8 %	91,1 29.2 %	115,1 15.9 %	212,6 19.1 %
Opioids	139 9.8 %	37,9 10.1 %	38,5 12.3 %	539 7.5 %	979 8.8 %	16,3 11.5 %	39,5 10.6 %	39,7 12.7 %	545 7.5 %	990 8.9 %
Cocaine	68 4.8 %	190 5.1 %	175 5.6 %	262 3.6 %	457 4.1 %	79 5.6 %	214 5.7 %	186 6.0 %	237 3.3 %	465 4.2 %
Alcohol	86 6.1 %	191 5.1 %	231 7.4 %	221 3.1 %	455 4.1 %	68 4.8 %	187 5.0 %	196 6.3 %	182 2.5 %	403 3.6 %
Tobacco	65 4.6 %	160 4.3 %	239 7.7 %	296 4.1 %	484 4.4 %	86 6.1 %	180 4.8 %	281 9.0 %	281 3.9 %	521 4.7 %
Psychiatric disorder (any), n (%) ^c	82,1 57.8 %	23,70 63.3 %	188,6 60.4 %	419,5 58.1 %	651,2 58.6 %	73,7 51.9 %	224,5 60.0 %	184,9 59.2 %	431,3 59.7 %	655,9 59.1 %
Major depressive disorder	130 9.2 %	39,7 10.6 %	31,3 10.0 %	644 8.9 %	10,14 9.1 %	121 8.5 %	39,7 10.6 %	33,0 10.6 %	649 9.0 %	10,23 9.2 %
Schizophrenia/schizoaffective	15,6 11.0 %	55,1 14.7 %	36,5 11.7 %	441 6.1 %	970 8.7 %	16,7 11.8 %	57,2 15.3 %	36,6 11.7 %	442 6.1 %	982 8.8 %
Bipolar disorder	94 6.6 %	315 8.4 %	253 8.1 %	468 6.5 %	765 6.9 %	81 5.7 %	288 7.7 %	259 8.3 %	452 6.3 %	723 6.5 %
PTSD	24 1.7 %	107 2.9 %	76 2.4 %	237 3.3 %	308 2.8 %	28 2.0 %	106 2.8 %	73 2.3 %	220 3.0 %	303 2.7 %
Anxiety disorder (any)	200 14.1 %	52,1 13.9 %	479 15.4 %	83,8 11.6 %	134,2 12.1 %	18,6 13.1 %	52,3 14.0 %	50,3 16.1 %	83,2 11.5 %	134,6 12.1 %
Substance use or psychiatric disorder, n (%) ^c	94,1 66.3 %	263,0 70.3 %	219,0 70.2 %	456,2 63.1 %	722,9 65.1 %	86,1 60.6 %	250,7 67.0 %	212,5 68.1 %	463,6 64.2 %	720,5 64.9 %

^aNote: patients were assigned to non-CCI primary care clinicians who provided the plurality of primary care claims (procedural terminology codes 9920x, 9921x, 9924x, 99381–99387, 99391–99397, 99401–99404, 99411–99412, 99420–99429, 99339–99340, 99341–99345, 99347–99350, 0402, G0438, and G0439)

^bComorbidity Index was calculated using the Agency for Healthcare Research and Quality software tool: <http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>

^cThese values represent claims for the respective disorders in the one year prior to the index date. The creation of the sample, however, was based on patients who had a behavioral health (and medical) claim at any point during 2005 to 2010 and not only prior to the index date. Thus, the percent with a substance use or psychiatric disorder claim in this table is not 100 %. Also, patients could have more than one of the four medical disorders (thus, the sum of the four columns of medical disorders is greater than the total N)

ICD9 codes used to identify each disease category are as follows:

Diabetes: 250, 3572, 3620, 36641, 6480

CHF: 40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4280, 4281, 4282, 4284, 4289

Asthma: 493

COPD: 494, 496, 500, 501, 502, 503, 504, 505, 510, 515, 4920, 4928, 49320, 49321, 49322, 4940, 5060, 5081, 5100, 5109, 5160, 5161, 5162, 5163, 5168, 5169, 5171, 5172, 5181, 5182, 5183, 51882, 51883, 51884

Mental health and substance use disorder: 290, 293–302, 306–315

Substance use disorder: 291, 292, 303, 304, 305

percentages of patients that would be categorized into the same diagnostic group was highly similar (ranging from 97.4 % to 99.8 %).

Utilization Analysis

Measures of utilization showed a significant decrease in use of ED and inpatient psychiatric utilization in the CCI group and a relative decrease in inpatient medical services for the CCI group compared to the non-CCI group (Table 3). For ED utilization, this represented a relative reduction of 13.9 percentage points in the proportion of patients with at least one ED visit (OR, 0.667; 95%CI, 0.574 to 0.774), and among those using the ED, there was a decrease of 15.6 % (95 % CI, 21.0 % to 9.7 %) in the expected mean counts of ED visits. There was an even larger relative decrease of 40.7 % (95 % CI, -57.0 % to -18.0 %) in mean counts of inpatient psychiatric services for the CCI group compared to the non-CCI group. The proportion of patients with any inpatient medical claims increased in the non-CCI group, but decreased slightly in the CCI group (relative decrease of 5.0 percentage points; OR, 0.737; 95 % CI, 0.603–0.900). The proportion of patients with any medical outpatient claim increased in both the CCI and non-CCI groups, though significantly less so in the CCI group, perhaps because of a ceiling effect (96.4 % of the CCI patients had a medical outpatient claim in the pre-index episode period).

Cost Analysis

The CCI group experienced average adjusted total cost savings of \$4145.28 per patient per year (95 % CI, \$597.35 to \$7693.21; $P=0.023$) (unadjusted savings = \$3064.91) relative to the non-CCI group (Table 4). The effect did not vary by region of the state (region by intervention group interaction: $P=0.79$). The decrease in overall cost was largely driven by a relative decrease in inpatient costs, specifically a \$3521.15 (95 % CI, \$53.08 to \$6989.22; $P=0.046$) decrease per patient per year in adjusted medical inpatient costs for patients in CCI practices. Relative decreases of \$21.54 in the costs of psychiatric ($P=0.001$) and \$16.42 in the costs of substance abuse services ($P=0.013$) both contributed to the overall decrease in outpatient costs.

Sensitivity analyses (not shown) of all CCI patients with their nearest neighbor removing the caliper restriction yielded significant findings ($P=0.019$), and the total cost difference between the CCI ($n=12,046$ patients) and non-CCI ($n=12,046$ patients) was \$3744.798 (adjusting for pre-index episode total costs, region, and the propensity score). Thus, any bias attributable to incomplete matching did not appear to impact the estimation of the total cost effect. A second sensitivity analysis of all non-propensity-matched patients at these practices revealed a similar pattern of significant findings. The total cost difference between the CCI ($n=12,046$ patients) and non-CCI ($n=44,701$ patients) groups when all eligible Medicaid patients were included was \$7345.37 (adjusting for pre-index episode total costs, region, and the propensity score).

DISCUSSION

We found substantial cost savings, largely driven by decreases in hospital costs, over a 1-year period for continuously enrolled Medicaid patients with comorbid chronic medical and behavioral health conditions treated in PCMHs that were part of Pennsylvania's Chronic Care Initiative. We also found decreases in medical inpatient and outpatient psychiatric and substance abuse treatment costs. Significant decreases in utilization were evident for ED and psychiatric inpatient and psychiatric outpatient claims.

There is a substantial amount of published literature on the PCMH model, though evidence of its success has been mixed across geographies, patient populations, and study designs.^{30–36} Recent literature reviews, evaluating anywhere from 14–200 PCMH studies, have found that many have employed weak designs resulting in inconclusive evidence.^{37–41} Similarly, previous work on the Pennsylvania CCI also found mixed results, although these studies were limited to smaller sample sizes.^{12,17–19}

Our study adds to the literature by demonstrating the impact of a statewide PCMH program on high-risk publicly insured patients using a large sample size and robust design. In contrast to earlier studies,^{12,17} we focused specifically on a large, high-risk patient population with both medical and behavioral health comorbidities that, to our knowledge, has not been previously studied in this context. We chose this population because, in primary care, mental health illnesses are frequently unrecognized and undertreated, compromising medical treatment and increasing costs.^{42–48} Because mental health comorbidity has been associated with “elevated symptom burden, functional impairment, decreased length and quality of life, and increased costs,” there have been numerous calls for integration of behavioral health into primary care and PCMHs.^{2,21,42,43} Recent clinical trials have suggested that behavioral health integration can result in cost-savings over time.^{1,49,50} This population may be especially responsive to a focus on care management, care coordination, and patient-centered care.

Given that the average cost of a hospital admission is \$9700,⁵¹ it is not surprising that PCMHs targeting care coordination and reductions in ED visits that lead to inpatient admissions among high-risk populations can result in substantially decreased costs.⁴⁵ Indeed, another recent study of 15 CCI practices found reductions in hospital utilization and costs only among the subset of patients with multiple comorbidities, leading the authors to conclude “the average patient may not be the relevant unit of observation for evaluating the impact of PCMH adoption. Rather, high-risk patients with multiple comorbidities are the most logical targets for interventions.”¹⁹ Similar trends have also been seen in other care delivery models, such as the Medicare's Physician Group Practice Demonstration^{52,53} and some Accountable Care demonstrations,⁵⁴ which found differential reductions in cost among patients with chronic illness compared to all patients. Although we did not directly compare utilization/cost of high-

Table 3 Healthcare Utilization for Propensity Score-Matched Patients Treated in CCI and Non-CCI Practices

	Patients treated at non-CCI practices 2008-2010 (n = 11,105)			Patients treated at CCI practices 2008-2010 (n = 11,105)			Difference between pre-index to post-index change in CCI relative to pre-index to post-index change in non-CCI		P-value
	Pre-index episode	Post-index episode	Change pre-post	Pre-index episode	Post-index episode	Change pre-post	Difference-in-difference		
ER									
ER visits ^c	Any	74.2 %	+11.8 %	68.1 %	66.0 %	-2.1 %	-13.9 %	0.667 (0.574-0.774)	<0.001
	Count	3.48	+1.19	2.75	2.74	-0.01	-1.20	-15.6 % (-21.0 % to -9.7 %)	<0.001
	mean (SD)	(4.54)	(5.60)	(5.25)	(5.21)				
INPATIENT									
Psychiatric/mental health claims ^b	Count	1.87	-0.41	1.51	1.03	-0.48	-0.07	-40.7 % (-57.0 % to -18.0 %)	0.009
Substance abuse treatment claims ^b	mean (SD)	(15.74)	(14.40)	(12.52)	(10.17)				
Medical services claims ^a	Count	0.002	-0.001	0.002	0.001	-0.001	0.000	10.4 % (-47.3.0 % to 67.7 %)	0.33
	mean (SD)	(0.056)	(0.036)	(0.053)	(0.052)				
All claims ^a	Any	82.5 %	+4.9 %	85.3 %	85.2 %	-0.1 %	-5.0 %	0.737 (0.603-0.900)	0.006
	Count	8.20	+1.04	8.66	9.28	+0.62	-0.42	-2.0 % (-11.4 % to +8.4 %)	0.68
	mean (SD)	(14.23)	(15.80)	(14.43)	(15.64)				
	Any	83.1 %	+4.9 %	85.7 %	85.6 %	0.0 %	-4.9 %	0.721 (0.590-0.883)	0.004
	Count	10.40	+0.63	10.10	10.25	+0.15	-0.48	-4.6 % (-13.9 % to +5.7 %)	0.37
	mean (SD)	(21.03)	(21.11)	(18.92)	(18.54)				
OUTPATIENT									
Psychiatric/mental health claims ^a	Any	36.2 %	+1.3 %	36.2 %	35.0 %	-1.2 %	-2.5 %	0.799 (0.704-0.906)	0.002
	Count	6.62	-0.32	6.57	5.70	-0.87	-0.55	-17.2 % (-26.1 % to -7.2 %)	0.004
	mean (SD)	(20.87)	(18.93)	(20.97)	(18.53)				
Substance abuse treatment claims ^b	Count	2.94	+2.05	2.89	3.29	+0.40	-1.65	-26.2 % (-64.6 % to +53.7 %)	0.47
Medical services claims ^c	mean (SD)	(32.32)	(32.32)	(22.35)	(25.64)				
	Any	93.3 %	+3.7 %	96.4 %	99.3 %	+2.9 %	-0.6 %	0.274 (0.186-0.402)	<0.001
	Count	14.94	+3.00	15.40	18.87	+3.47	+0.47	+5.8 % (+2.1 % to +9.7 %)	0.004
	mean (SD)	(24.14)	(26.39)	(23.47)	(24.94)				
Pharmacy claims ^b	Count	20.71	-0.11	20.56	22.35	+1.79	+1.90	+8.6 % (-0.0 % to +18.0 %)	0.061
	mean (SD)	(21.27)	(20.84)	(21.04)	(21.66)				
All claims ^d	Count	45.21	+4.62	45.42	50.21	+4.79	+0.17	+1.5 % (-2.3 % to +5.4 %)	0.46
	mean (SD)	(48.41)	(54.78)	(48.27)	(50.05)				
Total	Count	57.90	+6.44	58.27	63.20	+4.94	-1.50	-2.5 % (-5.6 % to +0.1 %)	0.36
	mean (SD)	(57.91)	(63.58)	(56.82)	(58.81)				

^aAnalyzed using the zero-inflated negative binomial model (ZINB)

^bAnalyzed using the negative binomial model

^cAnalyzed using the zero-inflated generalized Poisson model

^dAnalyzed using the generalized Poisson model

Note: "Any" is defined as the proportion of patients with at least one claim in each category of service. "Count mean (SD)" is defined as the unadjusted mean number of claims per patient in each category of service. For zero inflated analyses, the mean count is only for those patients with at least one claim in that category of service

Table 4 Healthcare Costs in Dollars for Propensity Score-Matched Patients Treated in CCI and non-CCI Practices

	Patients treated at non-CCI practices 2008–2010 (n = 11,105)			Patients treated at CCI practices 2008–2010 (n = 11,105)			Difference between pre-index to post-index change in CCI relative to pre-index to post-index change in non-CCI		
	Pre-index episode, mean (SD)	Change pre-post	Post-index episode, mean (SD)	Pre-index episode, mean (SD)	Change pre-post	Post-index episode, mean (SD)	Difference in changes of unadjusted mean costs	Difference in changes of adjusted mean costs	P-value
ER									
Cost of ER ^a	187.12 (412.06)	+79.47	266.59 (626.59)	206.86 (445.83)	+77.84	284.69 (867.09)	-1.63	+13.35	0.67
INPATIENT									
Cost of psychiatric/mental health services ^b	548.50 (4795.12)	-68.52	479.99 (6682.30)	393.45 (4047.81)	+165.48	558.92 (5800.56)	+234.00	+213.90	0.08
Cost of substance abuse treatment ^b	3.34 (142.56)	-2.16	1.17 (69.88)	3.01 (99.80)	+0.92	3.94 (162.72)	+3.08	+3.09	0.19
Cost of medical services ^a	12,844.80 (69,195.48)	+804.07	13,648.86 (74,283.37)	11,864.66 (70,795.81)	-2856.86	9007.80 (68,846.02)	-3660.93	-4506.06	0.033
Total cost inpatient ^a	13,396.64 (69,362.19)	901.34	14,297.98 (74,598.27)	12,261.12 (70,914.06)	-2538.46	9722.66 (69,166.48)	-3439.81	-3521.15	0.046
OUTPATIENT									
Cost of psychiatric/mental health services ^c	139.01 (352.82)	-20.44	118.57 (321.53)	134.30 (334.45)	-41.58	92.72 (306.34)	-21.13	-21.54	<0.001
Cost of substance abuse treatment ^b	47.17 (284.85)	+3.37	50.54 (349.81)	47.26 (294.92)	-10.23	37.03 (290.65)	-13.60	-16.42	0.013
Cost of medical services ^c	1106.52 (1970.03)	+226.59	1333.11 (2262.72)	1135.44 (2010.56)	+236.37	1371.81 (2238.96)	+9.78	+15.47	0.43
Cost of outpatient pharmacy services ^a	4203.74 (7701.03)	+117.43	4321.17 (8823.18)	4129.09 (7898.02)	+307.89	4436.91 (8609.01)	+190.46	+199.44	0.097
Total cost Outpatient ^c	5496.45 (8410.80)	+316.60	5813.05 (9605.07)	5446.08 (8617.16)	+497.22	5943.29 (9463.54)	+180.62	+174.39	0.11
Total cost ^c	19,080.20 (70,440.01)	+1219.94	20,300.15 (76364.22)	17,914.06 (71847.29)	-1844.96	16,609.09 (70,348.69)	-3064.91	-4145.28	0.023

Note: Analyses were conducted on transformed variables but back-transformed values are shown in this table. Because these are back-transformed values, and because of the use of practice as a clustering variable, summing the mean values for the individual cost variables in this table does not reproduce the mean value for the total cost variable. Adjusted mean costs are adjusted for covariates

^aNo transformation
^bSquare-root transformation
^cLog transformation

risk (medical/psychiatric comorbid) and non-high-risk patients, the cost savings suggest that PCMHs could strengthen their emphasis on this population by allocating training/monitoring of behavioral health integration to achieve both optimal care and cost reductions.

The mixed evidence in the PCMH literature highlights the reality that the medical home is not a universal remedy for improving quality while lowering costs but a care delivery model that has experienced variation in implementation, methods of evaluation, outcomes studied, and effectiveness in different settings for different populations. We must be careful to tout the PCMH as neither a panacea nor a failed innovation but to understand the complexity of the areas in which the PCMH delivers the greatest value.

Our study has several important limitations. First, we do not have claims data for non-Medicaid payers nor do we have data on the cost of investment and operation of the CCI program. Thus, we cannot draw conclusions about overall cost-effectiveness. Second, our study only investigated a 1-year period post-index episode for each patient; we do not know if the short-term benefits would translate into long-term benefits. Third, for dual-eligible patients, not all services obtained would be captured in the Medicaid databases. It is possible that the omission of these services would bias our results; however, the CCI and controls were propensity matched on any SSDI or Medicare co-payments. Fourth, the sample was created by including patients who had the target medical and psychiatric/substance use diagnoses either before or after the start of the intervention. Thus, the results do not necessarily generalize to a population with such diagnoses prior to the initiation of a medical home model. Fifth, it is possible that more motivated and well-equipped practices may have disproportionately joined the CCI, creating a selection bias. Sixth, our matching algorithm excluded 941 CCI patients that could not be matched with patients in the comparison practices. To generalize our results to the full set of CCI patients meeting our inclusion/exclusion criteria requires the assumption that the parameter values on which our cost/utilization values are based would be similar if these 941 patients were included. However, this assumption cannot be tested given that no adequate matches for these patients in the comparison practices were found. Finally, our study investigated utilization and cost through claims databases and did not measure the quality or the PCMH experience from the patient's perspective.

CONCLUSION

We found that, for a high-risk group of Medicaid patients with medical and mental health comorbidities, the CCI was associated with substantial cost savings and identifiable changes in patterns of healthcare utilization. These findings suggest that

the patient-centered medical home model may be beneficial and reduce costs among high-risk patients with chronic physical and behavioral health comorbidities who may disproportionately benefit from its unique features.

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