# Impact of a Medical Home Model on Costs and Utilization Among Comorbid HIV-Positive Medicaid Patients

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## ABSTRACT

**OBJECTIVES:** The Pennsylvania Chronic Care Initiative (CCI) was a statewide patient-centered medical home (PCMH) initiative implemented from 2008 to 2011. This study examined whether the CCI affected utilization and costs for HIV-positive Medicaid patients with both medical and behavioral health comorbidities.

**STUDY DESIGN:** Nonrandomized comparison of 302 HIV-positive Medicaid patients treated in 137 CCI practices and 2577 HIV-positive Medicaid patients treated elsewhere.

**METHODS:** All patients had chronic medical conditions (diabetes, chronic obstructive pulmonary disease, asthma, or congestive heart failure) and a psychiatric and/or substance use disorder. Analyses used Medicaid claims data to examine changes in total per patient costs per month from 1 year prior to 1 year following an index episode. Propensity score weighting was used to adjust for potential sample differences. Secondary outcomes included costs and utilization of emergency department, inpatient, and outpatient/pharmacy services.

**RESULTS:** We identified an average total cost savings of $214.10 per patient per month ($P$ = .002) for the CCI group relative to the non-CCI group. This was a function of decreased inpatient medical (–$415.69; $P$ = .007) and outpatient substance abuse treatment (–$4.86; $P$ = .001) costs, but increased non-HIV pharmacy costs ($158.43; $P$ = .001). Utilization for the CCI group, relative to the non-CCI group, was correspondingly decreased for inpatient medical services (odds ratio [OR], 0.619; $P$ = .002) and inpatient services overall (OR, 0.404; $P$ = .001), but that group had greater numbers of outpatient medical service claims when they occurred (11.7%; $P$ = .003) and increased non-HIV pharmacy claims (9.7%; $P$ = .001).

**CONCLUSIONS:** There was increased outpatient service utilization, yet relative cost savings, for HIV-positive Medicaid patients with medical and behavioral health comorbidities who were treated in PCMHs.

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Individuals with HIV have increased rates of depression, substance use, and other serious psychiatric disorders.[1-4] A variety of medical comorbidities, including diabetes,[5,6] heart failure,[7,8] and obstructive lung disease,[9,10] are also common. Moreover, recent evidence suggests that psychiatric and substance use disorders may be especially important risk factors for cardiovascular and other medical comorbidities among HIV-positive individuals.[8,11]

Within the general population, having more than 1 chronic disease is associated with increased mortality, poor functional status, decreased quality of life, unnecessary hospitalizations, and increased medical costs.[12,13] The presence of psychiatric and substance use disorders in those with HIV has also been linked to increased healthcare utilization.[14] Despite the prevalence and importance of both medical and psychiatric comorbidities among HIV-positive patients, comorbid disorders often go unrecognized and untreated.[10,15,16]



The patient-centered medical home (PCMH) has the potential to identify and address comorbidity through core elements such as a whole-person orientation, behavioral health integration, emphasis on quality, enhanced access, use of health information technology, and coordination of outpatient care.[17] Although evidence for cost savings and improved clinical outcomes has been mixed when PCMH models have been applied in the general population,[18-20] implementation of a PCMH model for those with chronic diseases, such as diabetes, hypertension, and coronary heart disease, and high levels of comorbidity has been associated with relatively better clinical outcomes and reduced total healthcare costs.[21]

The federal Ryan White HIV/AIDS Program brings elements of a medical home to those with HIV by providing funding for primary medical care and additional support services. However, despite being targeted toward those who do not have sufficient healthcare coverage or financial resources to cope with HIV/AIDS, Ryan White funding does not apply to those with Medicaid coverage.

Beginning in 1997, Pennsylvania introduced HealthChoices, a risk-based managed care program that was initially offered in certain counties and then expanded to cover more counties and services. By mid-2009, 72% of all Pennsylvania Medicaid beneficiaries were enrolled in some form of managed care. Enrollment became

mandatory for most Medicaid beneficiaries by 2013 in the counties where the program operates.

During 2008 to 2011, the state conducted one of the largest statewide multipayer PCMH experiments in the United States. This experiment, the Pennsylvania Chronic Care Initiative (CCI),[22] was in place from 2008 to 2011. The Pennsylvania Department of Health provided leadership and financial support for practice transformation, requiring CCI practice managers to attend learning sessions, report monthly quality metrics, and use assigned practice coaches. These strategies were specifically based on the Chronic Care Model.[23] All CCI sites received behavioral health training, integrated depression screening using validated tools, and were coached to develop a process for coordinating behavioral and medical care. Practices were selected for participation in the CCI through a voluntary application process. The PCMH model was implemented for all patients receiving services at participating practices. In total, 152 primary care practices involving 640 providers participated in the CCI, with more than 1.18 million patients receiving care.

**TAKEAWAY POINTS**

The Pennsylvania Chronic Care Initiative (CCI) was a patient-centered medical home (PCMH) initiative implemented from 2008 to 2011. This study examined whether the CCI affected utilization and costs for HIV-positive Medicaid patients with both medical and behavioral health comorbidities compared with similar patients treated in non-CCI practices.

- Relative cost savings are evident for HIV-positive patients seen in PCMHs due to reduced inpatient medical and outpatient substance abuse treatment costs.
- HIV-positive patients seen in a PCMH had higher outpatient healthcare service utilization and an increased number of non-HIV pharmacy claims.
- Implementation of a PCMH for HIV-positive patients should be targeted to those with behavioral health and medical comorbidities.

Evaluations of the CCI using all-payer claims data have been mixed.[24,25] Recent analyses found reductions in emergency department (ED) use overall, as well as reduced cost and hospitalization among high-risk patients with chronic conditions.[26-28] Prior work suggests that Medicaid patients with medical and psychiatric comorbidities may benefit disproportionately from the structural advantages of the PCMH model due to the complexity of managing their illnesses, generating significantly lower costs.[28-30]

We previously reported that reductions in healthcare utilization and costs were evident for Medicaid patients treated with the PCMH model implemented in CCI practices.[28] However, no analysis to date has determined whether such cost savings would apply to HIV-positive patients with medical and psychiatric comorbidities. Patients with HIV were a small component of the matched samples examined in the previous study of cost and utilization outcomes in the CCI,[28] representing only 2.3% of that sample. A larger group of HIV-positive patients was available for analysis in the Pennsylvania Medicaid database, with 17.5% of such patients included in the previous matched sample analyses. Thus, it was not clear if findings for a non-HIV sample would generalize to an HIV-positive sample.

The current study tested the hypothesis that significant reductions in healthcare utilization and costs would be evident for HIV-positive patients with medical and psychiatric comorbidities who were treated in a CCI practice compared with similar patients treated in a non-CCI practice.

# METHODS

We examined pre-post healthcare utilization and costs for HIV-positive Medicaid patients with at least 1 of 4 chronic medical conditions, plus at least 1 psychiatric and/or substance use disorder, comparing changes in healthcare utilization and costs among patients treated in CCI and non-CCI practices. This study was approved by the University of Pennsylvania Institutional Review Board with a waiver of informed consent and complied with the ethical standards of the Office for Human Research Protections.

## Data

We initially obtained a list of 147 CCI practices from the Pennsylvania Department of Health. Identifying information for 5 of the 152 practices in the CCI was not in the list provided. Of the remaining 147, we excluded 10 that did not serve Medicaid patients, reducing the sample to 137 CCI practices. Using a Medicaid claims dataset obtained from the Pennsylvania Department of Human Services, we identified HIV-positive patients treated in the CCI practices and those treated in non-CCI practices during the time period the CCI was active. We identified HIV-positive patients with an *International Classification of Diseases, Ninth Revision* code of 042 (attached to at least 2 claims) who also had primary or secondary diagnostic codes for at least 1 of 4 chronic medical conditions (in any type of claim) and at least 1 claim (outpatient or inpatient nonlaboratory) for a psychiatric and/or substance use disorder. The 4 comorbid chronic medical conditions (diabetes, chronic obstructive pulmonary disease [COPD], asthma, and congestive heart failure [CHF]) were selected because they were identified as sources of disproportionate health and financial burdens by the Pennsylvania Health Care Cost Containment Council.[31] Comorbid behavioral health conditions included psychiatric (major depressive disorder, schizophrenia/schizoaffective disorder, bipolar disorder, posttraumatic stress disorder, and anxiety disorders) and substance use (opioid, cocaine, and alcohol) disorders. The psychiatric disorders chosen were the most prevalent and are associated with high healthcare costs within a Medicaid population.[32] The substance use disorders chosen were the 3 most common nationally (other than marijuana) for patients presenting at substance use treatment facilities during the target years.[33]

HIV-positive patients were considered part of the CCI group if they had at least 1 claim from a CCI practice. Patients with HIV who never had a claim from a CCI practice were placed in the comparison group. For each CCI patient, the first claim filed after the date the

patient's practice joined the CCI was identified as the "index episode." For patients in the comparison (non-CCI) group, the index episode was defined as the first claim filed after commencement of the CCI program. In the original sample, there were 404 CCI patients and 4039 non-CCI patients diagnosed as HIV positive. To be included in the study, a patient needed to have at least 6 months of Medicaid eligibility during the year prior and the year following the index episode. This restriction resulted in a sample of 302 CCI HIV-positive patients and 2577 non-CCI HIV-positive patients. The date of the index episode was used to mark the first exposure of each patient to the "intervention" of the CCI, allowing for a pre-post intervention comparison, as has been done in other studies.[34,35]

Patients eligible for both Medicaid and Medicare were included, as many patients with chronic mental health and substance abuse conditions have such dual eligibility. For the target sample, we identified the presence of both chronic medical conditions and behavioral health diagnoses from claims at any point during the 2005-2010 time period, whether before or after the index episode date. This was done because the medical and psychiatric disorders targeted in this study typically are chronic conditions that manifest first as subthreshold symptoms and, if managed well, can be prevented from evolving into full diagnoses.

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. Notably, capitated Medicaid managed care plans also 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 Pennsylvania Medicaid average costs by diagnosis-related groups using fee-for-service data. We separately calculated pharmacy costs for antiretroviral drugs and other medications.

### Outcomes

We compared pre-post changes in healthcare utilization and costs for HIV-positive patients treated at CCI practices with changes in utilization and costs for non-CCI HIV-positive patients in the same year. Changes in utilization and costs were measured from the 1-year pre–index episode period to the 1-year post–index episode period, with costs and counts calculated per month eligible for Medicaid.

### Statistical Analysis

The primary outcome measure was the difference between CCI and non-CCI patients in total healthcare cost changes per month eligible between the 1-year preindex period and the 1-year postindex period. Secondary outcomes included between-group differences in pre-post changes within specific ED, inpatient, pharmacy, and outpatient cost and utilization variables. Negative values for differences favored the CCI group over the non-CCI group and vice versa for positive values.

A propensity score was derived to address the potential lack of comparability of patients in CCI and non-CCI practices at the time of treatment initiation using variables listed in **Table 1**. Other variables included in the propensity score (not listed in Table 1) were disability status or Supplemental Security Income benefits, months of Medicaid eligibility, dual Medicaid and Medicare eligibility, year of index episode, and region within Pennsylvania. The propensity score was used as an inverse weighting factor in all analyses.[36,37] Covariates included in all models were pre–index year total costs for each patient, pre–index year total utilization for each patient, and year of preindex episode.

Primary analysis of the cost variables consisted of a weighted least squares model of difference-in-differences (DID) scores, including the covariates described above and the propensity score as a weighting factor. Analyses of healthcare utilization counts proceeded using either generalized Poisson (GP) models, zero-inflated GP models, negative binomial regression models, or zero-inflated negative binomial models with SAS PROC-GENMOD, PROC-GLIMMIX, and PROC-NLMIXED.[38,39] The choice between zero-inflated and noninflated models depended on the magnitude of the zero counts, assessed using Vuong's test.[40] The choice between GP and negative binomial was a function of whether there was underdispersion or overdispersion of the data, respectively. For the zero versus nonzero component of the zero-inflated models, differences between the CCI and non-CCI groups were described using odds ratios (ORs) with 95% CIs. For the GP, negative binomial regression, and count portion of the zero-inflated models, the exponential of the regression coefficient for the comparison between CCI and non-CCI cost differences was interpreted as the percent increase or decrease in the expected count for CCI compared with non-CCI.[41]

As an assessment of whether the propensity procedure successfully balanced the groups, we implemented the goodness-of-fit diagnostic steps described by Austin.[42] First, we derived and visually examined quintile side-by-side boxplots of the propensity score for the CCI and non-CCI groups. Finally, we derived the weighted conditional standardized difference for each of the baseline predictors in Table 1 and compared each with the unconditional standardized difference.[43]

## RESULTS

### Characteristics of Study Population

Table 1 provides details on demographics and health conditions for HIV-positive patients with medical and psychiatric comorbidities treated in CCI versus non-CCI practices. Although the CCI group had higher percentages of patients who were African American, higher baseline comorbidity scores, and higher prevalence of cocaine, opioid, and alcohol use disorders, there were no statistically significant between-group differences on any of these characteristics after weighting by propensity score. Average (SD) per patient total healthcare costs during the 1-year preindex period per month eligible were $2721.29 ($6323.52) for the non-CCI group and $2951.48 ($4854.14) for the CCI group ($t = -0.75$; $P = .43$, without adjusting for propensity score). The results of the weighted

**TABLE 1.** Characteristics of CCI Sample and Controls

| | | Patients Treated at Non-CCI Practices, 2008-2010 (n = 2577) | Patients Treated at CCI Practices, 2008-2010 (n = 302) |
|---|---|---|---|
| **Patient Characteristics** | | | |
| Gender, male, n (%) | | 1318 (51.1) | 137 (45.4) |
| Race, n (%) | | | |
| White | | 562 (21.8) | 43 (14.2) |
| African American | | 1455 (56.5) | 230 (76.2) |
| Other | | 560 (21.7) | 29 (9.6) |
| Age, years, mean (SD) | | 44.9 (10.8) | 45.5 (10.7) |
| Comorbidity index,[a] mean (SD) | | 2.42 (1.89) | 3.29 (2.15) |
| Pre–index episode per patient cost per month eligible, $, mean (SD) | | 2721.29 (6323.52) | 2951.48 (4854.14) |
| **Chronic Medical Disorders** | ***ICD-9* Codes** | | |
| Asthma, n (%) | 493 | 1222 (47.8) | 151 (50.0) |
| CHF, n (%) | 40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4280-4282, 4284, 4289 | 480 (18.6) | 67 (22.2) |
| COPD, n (%) | 494, 496, 500-505, 510, 515, 4920, 4928, 49320-49322, 4940, 5060, 5081, 5100, 5109, 5160-5163, 5168, 5169, 5171, 5172, 5181-5183, 51882-51884 | 1263 (49.0) | 140 (46.3) |
| Diabetes, n (%) | 250, 3572, 3620, 36641, 6480 | 1009 (39.2) | 110 (36.4) |
| Substance use disorder (any), n (%)[b] | 291, 292, 303-305 | 940 (36.5) | 141 (46.7) |
| Opioids | | 594 (22.1) | 87 (28.8) |
| Cocaine | | 338 (13.1) | 61 (20.2) |
| Alcohol | | 110 (4.3) | 29 (9.6) |
| Tobacco | | 122 (4.7) | 13 (4.3) |
| Psychiatric disorder (any), n (%)[b] | 290, 293-302, 306-315 | 1420 (55.1) | 185 (61.3) |
| Major depressive disorder | | 235 (9.1) | 45 (14.9) |
| Schizophrenia/schizoaffective disorder | | 232 (9.0) | 42 (13.9) |
| Bipolar disorder | | 153 (5.9) | 31 (10.3) |
| PTSD | | 53 (2.1) | 13 (4.3) |
| Anxiety disorder (any) | | 305 (11.8) | 40 (13.3) |
| Substance use or psychiatric disorder, n (%)[b] | | 1749 (67.9) | 223 (73.8) |

CCI indicates Chronic Care Initiative; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; *ICD-9*, *International Classification of Diseases, Ninth Revision*; PTSD, posttraumatic stress disorder.

[a]Comorbidity index was calculated without the HIV/AIDS variable using the Agency for Healthcare Research and Quality software tool (hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp).

[b]These values represent claims for the respective disorders in the 1 year prior to the index date. Patients were included in the sample if they had behavioral health claims at any point between 2005 and 2010. Thus, the proportion of patients with a substance use or psychiatric disorder claim in this table is not 100%. Also, some patients had more than 1 of the 4 medical disorders. Thus, the sum of the 4 columns of medical disorders is greater than the total N.

conditional standardized difference analyses revealed that for most variables in Table 1, except presence of any psychiatric disorder, the weighted conditional standardized difference was smaller than the standardized difference. For presence of any psychiatric disorder, the standardized difference was 0.026 and the weighted conditional standardized difference was 0.091. Although the weighted conditional standardized difference was slightly larger than the standardized difference, it still fell below the recommended 0.10 threshold for concern about a potential residual imbalance between the treatment groups.[44] Visual assessment of the balance of propensity scores using quintile plots showed adequate balance between CCI and non-CCI over the quintiles. We conclude that the CCI and non-CCI groups were adequately balanced following the propensity adjustment.

## Cost Analysis

The adjusted mean total cost DID scores for the CCI group relative to the non-CCI group were –$214.10 (95% CI, –$345.65 to –$82.55) per patient per eligible month ($P = .002$) (**Table 2**). This effect did not vary significantly by region of the state (region by intervention group interaction, $P = .14$). The most significant contributors to this cost savings were relatively greater decreases in inpatient medical costs (–$415.69 per patient per eligible month; $P = .007$) and outpatient substance abuse treatment costs (–$4.86; $P = .001$)

**TABLE 2.** Propensity Score–Adjusted Healthcare Costs Per Patient Per Eligible Month[a]

| | Patients Treated at Non-CCI Practices, 2008-2010 (n = 2577) | | | Patients Treated at CCI Practices, 2008-2010 (n = 302) | | | Difference Between Pre-Post Change in CCI Relative to Non-CCI | |
|---|---|---|---|---|---|---|---|---|
| | Pre–Index Episode, Mean (SD) | Post Index Episode, Mean (SD) | Change Pre-Post | Pre–Index Episode, Mean (SD) | Post Index Episode, Mean (SD) | Change Pre-Post | Difference in Changes of Mean Costs (95% CI) | *P* |
| ED | 16.46 (33.88) | 24.29 (908.31) | 7.83 | 33.96 (65.17) | 39.86 (87.52) | 5.90 | −1.94 (−35.94 to 32.12) | .91 |
| Inpatient | | | | | | | | |
| Psychiatric and mental[b] health services | 40.75 (402.71) | 22.43 (314.68) | −18.32 | 25.90 (156.86) | 28.25 (178.72) | 2.35 | 20.67 (−1.35 to 42.69) | .067 |
| Substance abuse treatment | 1.95 (42.62) | 0.97 (22.43) | −0.97 | 1.84 (23.00) | 2.19 (38.03) | 0.35 | 1.32 (−6.77 to 9.41) | .75 |
| Medical services[c] | 1372.16 (5971.72) | 1676.03 (6467.60) | 303.87 | 1598.79 (4428.63) | 1486.97 (3832.67) | −111.82 | −415.69 (−716.34 to −115.04) | .007 |
| Total inpatient[c] | 1414.86 (5984.70) | 1699.43 (6471.65) | 284.58 | 1626.53 (4426.24) | 1517.40 (3831.37) | −109.13 | −393.71 (−759.43 to −27.99) | .035 |
| Outpatient | | | | | | | | |
| Psychiatric and mental health services | 8.36 (20.49) | 8.26 (19.38) | −0.11 | 7.63 (22.84) | 7.23 (15.45) | −0.40 | −0.30 (−5.65 to 5.05) | .92 |
| Substance abuse | 9.36 (36.41) | 12.39 (45.43) | 3.03 | 11.11 (37.68) | 9.28 (34.18) | −1.83 | −4.86 (−7.48 to −2.23) | .001 |
| Medical services | 103.02 (188.36) | 134.82 (226.85) | 31.79 | 143.07 (313.09) | 170.98 (302.77) | 27.90 | −3.89 (−22.95 to 15.17) | .69 |
| Pharmacy[b] | 1169.86 (1492.37) | 1236.43 (1384.26) | 66.57 | 1129.19 (1067.87) | 1386.35 (1406.96) | 257.17 | 190.60 (65.66-315.54) | .003 |
| Non-HIV pharmacy[c] | 686.07 (1096.89) | 711.28 (959.70) | 25.22 | 694.80 (824.07) | 878.45 (1077.41) | 183.65 | 158.43 (68.42-248.44) | .001 |
| HIV pharmacy[b] | 483.79 (739.95) | 525.15 (704.81) | 41.36 | 434.39 (460.53) | 507.90 (610.77) | 73.51 | 32.16 (−50.78 to 115.09) | .76 |
| Total outpatient[b] | 1290.60 (1533.95) | 1391.90 (1435.50) | 101.30 | 1290.99 (1174.94) | 1573.83 (1506.34) | 282.84 | 181.54 (68.94-294.14) | .002 |
| Total cost | 2721.91 (6326.52) | 3115.62 (6748.74) | 393.71 | 2951.48 (4854.14) | 3131.09 (4187.62) | 179.61 | −214.10 (−345.65 to −82.55) | .002 |

CCI indicates Chronic Care Initiative; ED, emergency department.

[a]Analyses were conducted on transformed variables, but back-transformed values are shown in this table. Because these are back-transformed values, summing the mean values for the individual cost variables in this table does not reproduce the mean value for the total cost variable. Costs are given in dollars per eligible month. Negative values for differences favored the CCI group over the non-CCI group and vice versa for positive values.

[b]Square-root transformation.

[c]Logarithmic transformation.

for the CCI group compared with the non-CCI group. Exploratory analyses examined the CCI versus non-CCI difference in outpatient substance abuse treatment costs separately for the subgroups of patients with and without a substance use disorder. The overall effect was carried by the patients with a substance use disorder (n = 141 and 940 for CCI and non-CCI groups, respectively), with a relative reduction in costs of $12.25 (95% CI, −$17.57 to −$6.93; *P* <.001) for the CCI group compared with the non-CCI group. There was no significant difference in outpatient substance abuse treatment costs for patients without a substance use disorder diagnosis.

The CCI group increased outpatient costs significantly from the pre- to postindex periods relative to the non-CCI group ($181.54; 95% CI, $68.94-$294.14; *P* = .002), with this effect driven by greater increases in non-HIV pharmacy costs ($158.43; 95% CI, $68.42-$248.44; *P* =.001). To further understand this increase in non-HIV pharmacy costs, these costs were subdivided into costs for medications for substance use disorder, psychotropic medications, and other medical non-HIV medication costs. No significant differences between the CCI and non-CCI groups were evident for psychotropic or substance use medications; medical (non-HIV) pharmacy costs were significantly higher for the CCI group compared with the non-CCI group ($153.94; 95% CI, $65.94-$241.91; *P* = .001).

## Utilization Analysis

Relative reductions in healthcare utilization for CCI compared with non-CCI patients were evident for inpatient services (**Table 3**). For inpatient services of any type, the CCI group had a reduction in

**TABLE 3.** Propensity Score–Adjusted Healthcare Utilization Per Patient Per Eligible Month[a]

| | | Patients Treated at Non-CCI Practices, 2008-2010 (n = 2577) | | | Patients Treated at CCI Practices, 2008-2010 (n = 302) | | | Difference Between Preindex to Postindex Change in CCI Relative to Non-CCI | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre–Index Episode | Post Index Episode | Change Pre-Post | Pre–Index Episode | Post Index Episode | Change Pre-Post | Raw DID | Any: OR (95% CI) Counts: % Change in Expected Mean Count (95% CI) | *P* |
| ED[b] | Any, % | 63.6% | 71.8% | 8.2% | 81.8% | 80.8% | –1.0% | –9.2% | 1.03 (0.85-1.24) | .79 |
| | Count, mean (SD) | 0.208 (0.380) | 0.315 (0.513) | 0.107 | 0.435 (0.710) | 0.426 (0.780) | –0.009 | –0.116 | –4.7% (–15.9% to 8.2%) | .47 |
| Inpatient | | | | | | | | | | |
| Psychiatric and mental health[c] | Count, mean (SD) | 0.169 (1.204) | 0.144 (1.123) | –0.025 | 0.173 (0.924) | 0.145 (0.901) | –0.028 | –0.003 | –27.1% (–96.4% to 17.8%) | .28 |
| Substance abuse[c] | Count, mean (SD) | 0.001 (0.013) | 0.000 (0.008) | –0.001 | 0.001 (0.007) | 0.001 (0.010) | 0.000 | 0.001 | 42.6% (–82.8% to 984.5%) | .75 |
| Medical services[b] | Any, % | 85.4% | 90.0% | 4.5% | 94.4% | 96.4% | 2.0% | –2.5% | 0.619 (0.446-0.837) | .002 |
| | Count, mean (SD) | 0.841 (1.245) | 1.058 (1.630) | 0.216 | 1.347 (1.683) | 1.524 (2.226) | 0.177 | 0.039 | 1.4% (–4.2% to 7.3%) | .64 |
| All inpatient[b] | Any, % | 86.2% | 90.3% | 4.0% | 95.0% | 97.0% | 2.0% | –2.0% | 0.404 (0.280-0.575) | .001 |
| | Count, mean (SD) | 1.003 (1.716) | 1.197 (1.950) | 0.193 | 1.512 (1.872) | 1.658 (2.374) | 0.145 | –0.038 | –3.9% (–20.9% to 16.9%) | .69 |
| Outpatient | | | | | | | | | | |
| Psychiatric and mental health[b] | Any, % | 31.4% | 33.7% | 2.3% | 39.1% | 36.4% | –2.6% | –4.9% | 0.963 (0.810-1.144) | .67 |
| | Count, mean (SD) | 0.300 (0.838) | 0.290 (0.762) | –0.010 | 0.290 (1.169) | 0.236 (0.531) | –0.054 | –0.044 | –11.5% (–22.3% to 64.9%) | .52 |
| Substance abuse[b] | Count, mean (SD) | 0.593 (2.811) | 1.039 (4.230) | 0.445 | 0.835 (3.782) | 0.832 (3.526) | –0.003 | –0.448 | –11.7% (–39.4% to 28.7%) | .52 |
| Medical services[b] | Any, % | 92.5% | 96.5% | 4.1% | 96.7% | 99.3% | 2.6% | –1.5% | 0.978 (0.867-1.103) | .71 |
| | Count, mean (SD) | 1.310 (1.850) | 1.695 (2.096) | 0.385 | 1.959 (2.691) | 2.458 (2.847) | 0.500 | 0.115 | 11.7% (3.9%-20.3%) | .003 |
| Pharmacy[c] | Count, mean (SD) | 2.011 (1.730) | 2.016 (1.663) | 0.005 | 2.241 (1.730) | 2.472 (1.670) | 0.231 | 0.226 | 8.0% (3.2%-13.1%) | .0009 |
| Non-HIV pharmacy[c] | Count, mean (SD) | 1.829 (1.686) | 1.777 (1.521) | –0.052 | 1.999 (1.633) | 2.204 (1.561) | 0.205 | 0.257 | 9.7% (4.6%-15.1%) | .001 |
| HIV pharmacy[c] | Count, mean (SD) | 0.254 (0.319) | 0.239 (0.283) | –0.015 | 0.243 (0.299) | 0.267 (0.279) | 0.024 | 0.039 | 1.9% (–6.8% to 11.4%) | .69 |
| All outpatient[c] | Count, mean (SD) | 4.214 (4.311) | 5.040 (5.448) | 0.826 | 5.326 (5.448) | 5.999 (5.223) | 0.674 | –0.152 | –1.8% (–4.7% to 1.3%) | .25 |
| Total claims[c] | Count, mean (SD) | 5.425 (4.979) | 6.551 (6.122) | 1.126 | 7.273 (6.430) | 8.083 (6.264) | 0.810 | –0.406 | –2.5% (–8.0% to 2.8%) | .36 |

CCI indicates Chronic Care Initiative; DID, difference-in-differences; ED, emergency department; OR, odds ratio; ZINB, zero-inflated negative binomial model.

[a]"Any" is defined as the proportion of patients with at least 1 claim in each category of service. "Count, mean (SD)" is defined as the mean number of claims per patient per eligible month in each category of service. For ZINB analyses, the mean count is only for those patients with at least 1 claim in that category of service. Negative values for differences favored the CCI group over the non-CCI group and vice versa for positive values.

[b]Analyzed using ZINB.

[c]Analyzed using negative binomial model.

any usage from the pre- to postindex period, whereas the non-CCI group had an increase in any claims (OR, 0.404; 95% CI, 0.280-0.575; *P* = .001). The most significant contributor to this effect was inpatient medical services, for which the CCI group experienced a reduction in any services, whereas the non-CCI group had an increase in any claims (OR, 0.619; 95% CI, 0.446-0.837; *P* = .002). With respect to outpatient medical claims, there was a significantly greater increase in utilization for CCI patients compared with non-CCI patients when outpatient medical claims occurred, with the average difference in number of claims per month eligible increased by 11.7% (95% CI, 3.9%-20.3%; *P* = .003) for CCI compared with non-CCI patients. Additionally, there was a significant increase in pharmacy claims for CCI compared with non-CCI patients, with the average number of claims per month eligible increasing by 8.0% (95% CI, 3.2%-13.1%; *P* = .0009) for the CCI group relative to the non-CCI group. This increase was driven by significantly greater pharmacy claims for non-HIV medications for CCI compared with non-CCI patients (9.7%; 95% CI, 4.6%-15.1%; *P* = .001).

# DISCUSSION

Among HIV-positive Medicaid patients with comorbid medical conditions (asthma, COPD, CHF, and/or diabetes) and psychiatric and/or substance use disorders, our data indicate that Pennsylvania's Chronic Care medical home initiative resulted in substantial cost savings compared with non-CCI treatment in the state. Relative decreases in cost were apparent for outpatient substance abuse treatment, inpatient medical, and total inpatient services. Decreases in utilization of any inpatient medical services were evident. These decreases in costs and utilization occurred with concomitant increases in the cost and utilization of outpatient medical services and outpatient non-HIV pharmacy claims for CCI-treated patients relative to non-CCI patients. The CCI intervention apparently was successful in shifting inpatient costs and utilization to outpatient care and use of non-HIV medications.

Studies examining the PCMH model in general (non-HIV) medical populations have reported mixed effects in terms of both costs/utilization and clinical outcomes,[18-20] although many of these studies have had methodological weaknesses.[45] Initial smaller-sample reports on the PCMH model implemented in the Pennsylvania CCI have also been mixed.[24-26] However, the largest study of the CCI focused on Medicaid patients and found considerable cost savings and utilization reductions among patients with complicating conditions requiring more healthcare utilization than the general population.[28] Similarly, a study of privately insured patients in 15 of the CCI practices reported reductions in costs and utilization only among patients with multiple comorbidities.[27] A PCMH model implemented at the University of Texas, Houston, also appeared to improve outcomes and reduce costs in a high-risk predominantly Medicaid-insured pediatric population with chronic illnesses.[46] The current report extends these cost and utilization findings to an HIV-positive Medicaid population with both chronic medical and psychiatric and/or substance use comorbidities.

These findings have important implications for the future of HIV care. HIV-positive individuals are more likely than the general population to have psychiatric and/or substance use disorders, and their comorbidities may be more difficult to manage.[47] Whether HIV itself causes this complexity or characteristics that predispose people to HIV interfere with managing comorbid illnesses, the burden on providers to coordinate and implement effective care is greater for HIV-positive populations than for most other patient groups. The magnitude of the CCI versus non-CCI relative cost reduction ($214.10 per month) found here was smaller than that previously found ($345.44 per month) in a report targeting predominately non-HIV patients with the same set of comorbidities as specified in the current analyses.[28] It should be noted that the current sample, compared with the previous study, was older (45 vs 34 years), was more often male (51% vs 38%), and had a higher comorbidity index (mean [SD], 2.5 [1.9] vs 1.5 [1.5]). Whether these sample differences, the difficulty of managing comorbidities within an HIV-positive population, or the continuous use of expensive HIV medications is responsible for the lower cost savings found here is not clear. Nevertheless, the cost savings in the current sample were meaningful, and our findings suggest that coordination of behavioral and medical care is a skill that can be taught to providers and practices and results in more efficient care. The CCI model appears to empower medical providers to be better managers of this complex population by emphasizing integrated, rather than siloed, care.

## Limitations

It is important to note several limitations of the current study. First, this study was restricted to Medicaid patients. We do not know whether the cost savings found for HIV-positive patients with Medicaid treated in the CCI would generalize to privately insured HIV-positive patients with or without the comorbidities examined here. Second, because participation in the CCI was voluntary for each practice, the results reported here could be a function of selection bias rather than the intervention per se. Third, we were not able to control for practice in the analyses, because individual comparison (non-CCI) practices with adequate numbers of HIV-positive patients were not available. Fourth, healthcare costs and utilization were only evaluated for 1 year post the index episode. Fifth, outcome measures were restricted to utilization and cost variables obtainable through a claims database. We did not have data on the quality of implementation of the medical home model; such implementation variables may be important for utilization and costs. We also did not have data on clinical outcomes. Without such data, it is difficult to know if cost reductions, for example, in outpatient substance abuse treatment costs, represent appropriate (eg, elimination of treatment that is not evidence based, improvement in substance use outcomes) versus inappropriate (eg, early termination of treatment) care. Future research needs to assess both clinical outcomes and costs to fully understand the basis for reductions in costs. Sixth, our focus was on 4 chronic medical conditions (COPD, heart failure, asthma, diabetes) that were highlighted in the CCI model. The impact of a PCMH on costs and clinical outcomes when other chronic medical conditions (eg, hypertension) are comorbid with HIV and psychiatric or substance use disorders needs to be examined in future research.

# CONCLUSIONS

The current study found that among HIV-positive Medicaid patients with medical and psychiatric comorbidities, the Pennsylvania CCI was associated with overall cost savings and relative decreases in inpatient healthcare utilization. The CCI model should be considered for permanent implementation in this population and adapted and tested for other complex medical conditions as well. ■

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