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# Health Care Spending And Use Among People Experiencing Unstable Housing In The Era Of Accountable Care Organizations

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**ABSTRACT** Provider organizations are increasingly held accountable for health care spending in vulnerable populations. Longitudinal data on health care spending and use among people experiencing episodes of homelessness could inform the design of alternative payment models. We used Medicaid claims data to analyze spending and use among 402 people who were continuously enrolled in the Boston Health Care for the Homeless Program (BHCHP) from 2013 through 2015, compared to spending and use among 18,638 people who were continuously enrolled in Massachusetts Medicaid with no evidence of experiencing homelessness. The BHCHP population averaged \$18,764 per person per year in spending—2.5 times more than spending among the comparison Medicaid population (\$7,561). In unadjusted analyses this difference was explained by greater spending in the BHCHP population on outpatient care, including emergency department care, as well as on inpatient care and prescription drugs. After adjustment for covariates and multiple hypothesis testing, the difference was largely driven by outpatient spending. Differences were sensitive to adjustments for risk score, which suggests that housing instability and health risk are meaningfully correlated. This longitudinal analysis improves understanding of health care use and resource needs among people who are homeless or have unstable housing, and it could inform the design of alternative payment models for vulnerable populations.

**H**ousing is a social determinant of health.<sup>1</sup> However, efforts to describe the relationship between unstable housing and health care spending and use have been limited by the lack of reliable data. In an era in which health care provider organizations are increasingly taking financial responsibility for population health and spending, understanding the contributions of social determinants such as unstable housing is essential. This understanding could inform the design of new population-based payment models that aim to support the

delivery of high-quality care for vulnerable populations, maintain financial viability for providers, and achieve cost savings for public programs.<sup>2</sup>

A prominent example of these alternative payment models, the accountable care organization (ACO) contracting model, is increasingly prevalent among providers that serve disadvantaged and low-income populations. This model of care has the potential to benefit vulnerable populations through improved access to primary care for patients who often use acute services, financial flexibility for behavioral health integration

for patients with a high burden of mental health need, and risk-adjusted payments for their providers. However, without adequate adjustment that takes into account social determinants of health such as housing, population-based payment models might not sufficiently finance providers for the health care of people they serve.

In 2018 the Massachusetts Medicaid program launched an ACO model across seventeen provider organizations in the state, some of whose attributed patients included homeless people.<sup>3</sup> As of February 2018 twelve states had Medicaid ACO programs, and at least ten more were pursuing them.<sup>4</sup> Thus, Massachusetts is an early model that may provide useful lessons for other states. To date, there has been a dearth of longitudinal research on important subpopulations—such as people experiencing unstable housing—that can provide valuable insights to inform Medicaid ACO programs.

Previous studies have noted a high rate of health care use, particularly emergency department and inpatient visits, among the homeless population in the US—even those who are insured.<sup>5–17</sup> However, while providing valuable groundwork, the literature has been largely cross-sectional,<sup>5–16</sup> based on self-reported data on health care use,<sup>8,9,11,13–16</sup> and not comprehensive.<sup>8–14</sup> Moreover, many of these studies focused on care delivered at a single clinical site or practice.<sup>10,14,15,17</sup> Many lacked a comparison group,<sup>5,9,10,13,15</sup> and few had data on health care spending in addition to use.<sup>5,7–9,11–17</sup> Finally, most of these studies were based on data from the period before the Affordable Care Act, when ACO contracts were less prevalent.<sup>5–7,9–16</sup>

This study examined Medicaid claims data across three years in a continuously enrolled population cared for by the Boston Health Care for the Homeless Program (BHCHP) in the Massachusetts Medicaid Primary Care Payment Reform Initiative (a value-based payment program that was a precursor to the state's Medicaid ACO program). We analyzed medical and pharmaceutical spending and use in the period 2013–15 and compared spending and use in the BHCHP population to those in a continuously enrolled Massachusetts Medicaid population with no evidence of experiencing homelessness in their health care records. In addition, we compared the prevalence of clinical diagnoses in the two populations.

## Study Data And Methods

**STUDY POPULATION** The BHCHP is one of the largest freestanding homeless health care programs in the US, serving 11,000 people across forty-five clinical sites throughout Boston. Ser-

vices include street outreach, shelter-based clinics, hospital-based primary care and behavioral health clinics, oral health care, and 104 medical respite beds to provide medical care to people who do not meet criteria for inpatient admission but are not well enough to stay in shelters or on the streets. The program was established in 1985, and its mission is to provide or ensure access to the highest-quality health care for people and families experiencing episodes of homelessness in greater Boston. The program does not ask for official proof of homelessness but cares for anyone referred to it or presenting as homeless at its clinical settings. Continuity of care is seen as critical to high-quality care in this sometimes hard-to-reach population, and the program often continues to follow individuals after they obtain housing.

We gathered longitudinal claims and enrollment data from the Massachusetts Medicaid program on people who were enrolled in the BHCHP from 2013 through 2015. During these years these people were also enrolled in the Primary Care Payment Reform Initiative. This initiative provided primary care practices with a risk-adjusted capitated payment with shared savings, quality incentives, and the possibility of shared risk—similar to other alternative payment models. Primary care clinicians were encouraged to coordinate care, assume accountability for total spending, and integrate behavioral health and primary care.<sup>18</sup>

We received Massachusetts Medicaid data on 3,907 adults younger than age sixty-five who were attributed to the BHCHP. People ages sixty-four and younger who were US citizens and who had resided in the US for at least five years were eligible for the Primary Care Payment Reform Initiative. We excluded 151 people who had no enrollment information in the data and excluded 3,354 people who were not continuously enrolled for all thirty-six months of the study period. This resulted in a sample of 402 people who were continuously enrolled in the BHCHP from 2013 through 2015. The longitudinal analysis, in contrast to cross-sectional analysis, has the potential to offer valuable insights to organizations that bear financial risk for attributed vulnerable populations in the ACO context, where contracts typically are for multiple years. Examining continuously enrolled people may render findings less generalizable to the entire homeless population, which is known to experience instability in many aspects of life.<sup>19</sup> Thus, in sensitivity analyses we compared the demographic characteristics of the people continuously enrolled in the BHCHP to those of people not continuously enrolled in it. We also compared the average spending of those who were continuously enrolled to

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that of people not continuously enrolled.

We compared people in the BHCHP to 18,638 people who were continuously enrolled in Massachusetts Medicaid and had no evidence of experiencing homelessness in their health care records. In the study period, these people were continuously enrolled in the Boston Medical Center HealthNet Plan, a large safety-net provider health plan that is a Medicaid plan for Massachusetts residents. Each person in this comparison group had at least one claim from the Primary Care Payment Reform Initiative during this period. We excluded people who experienced homelessness, as defined by having a claim during this period with an *International Classification of Diseases*, Ninth Revision (ICD-9), code for homelessness.

**DATA AND VARIABLES** We gathered information on the demographic and socioeconomic characteristics of the BHCHP population from claims data and BHCHP records. These characteristics included age, sex, race/ethnicity, primary language, disability status, monthly income, and veteran status. We also collected from BHCHP medical records the last known housing status of each person—including street, shelter, doubling up (that is, sharing the housing of another person as a result of loss of housing or economic hardship), transitional housing, supportive housing, and housing without support services. In our Massachusetts Medicaid comparison population, data were available on only age, sex, race/ethnicity, primary language, and disability status.

For both the BHCHP and comparison populations, we calculated a risk score for each person in each year using the Verisk Health Diagnostic Cost Group risk-score model, frequently used by insurers to risk-adjust capitated payments.<sup>20</sup> The risk score was calculated using age, sex, and ICD-9 or *International Statistical Classification of Diseases and Related Health Problems*, 10th Revision (ICD-10), codes, and it reflects expected spending based on demographic characteristics and total disease burden. In addition, we identified and compared the most prevalent clinical diagnoses in the two populations.

We aggregated health care spending and use in the claims data to the person-year level. Spending in both populations reflected established payment rates in the Massachusetts Medicaid program and included patient cost sharing, although for the vast majority of services, cost sharing was zero. We examined total medical spending as well as spending by type of service defined using the Berenson-Eggers Type of Service codes, which include clinical categories (as opposed to statistical or financial categories) that are relatively stable over time and constant

across all payers who use *Current Procedural Terminology* (CPT) codes for billing.<sup>21</sup> Within evaluation and management services, we studied office, hospital outpatient, emergency department, home, nursing home, psychiatry, and other specialist or consult visits. We also examined the remaining Berenson-Eggers Type of Service categories: procedures, imaging, tests, durable medical equipment, other, and exceptions or unclassified. In addition, we analyzed spending for and use of inpatient care and prescription drugs. Of note, we did not have access to substance use disorder claims from Massachusetts Medicaid because of common nationwide legal restrictions.<sup>22</sup> Specifically, claims were excluded if a substance use disorder diagnosis was coded as the primary diagnosis. However, claims in which substance use disorder diagnoses were not primary diagnoses were retained, but the substance use disorder diagnosis codes were omitted to maintain confidentiality. This applied to both the BHCHP and comparison populations.

**STATISTICAL ANALYSIS** In unadjusted analyses we compared average per person total medical spending and spending by outpatient, inpatient, and prescription drug categories between the BHCHP and Massachusetts Medicaid populations by year. We then compared average annual levels of per person spending and use between these groups for each category of service, using two-tailed *t*-tests.

In adjusted analyses we compared spending and use between these two groups in the aggregate and by category of service, adjusted for age, sex, race/ethnicity, primary language, disability status, and Verisk Health Diagnostic Cost Group risk score. Since homeless people have a substantially larger disease burden than most comparison populations do, and unstable housing can be correlated with disease burden, we also analyzed adjusted differences in spending and use without adjusting for the risk score. This helped capture to what extent the differences in spending and use were sensitive to adjustment for the risk score.

Multiple inference adjustment was conducted using the Westfall and Young method, which produced *p* values that accounted for the family-wise error rate.<sup>23</sup> All spending was inflation adjusted to 2015 US dollars. Analyses were performed using Stata, version 15.

This study was approved by the Harvard Medical School Institutional Review Board.

**LIMITATIONS** Our study had several limitations. First, our BHCHP population was continuously enrolled for three years (2013–15) and part of the Primary Care Payment Reform Initiative. Furthermore, housing status may have var-

ied for these patients over the study period, and the last captured housing status was the only status available. Overall, more than 60 percent of our sample had some form of housing during the study period. These attributes might have rendered these people less representative of the broader homeless population.<sup>24</sup>

Second, differences in risk scores may reflect differences not only in true disease burden but also in coding intensity (the extent to which providers code relevant diagnoses from a clinical encounter).<sup>25</sup>

Third, Massachusetts Medicaid behavioral health claims, including psychiatry claims, for the BHCHP population were provided by the Massachusetts Behavioral Health Partnership starting with claims for September 2013. Thus, comparisons of spending and use for psychiatry services relied on 2014 and 2015 data only.

Finally, the analysis was limited to claims in which substance use was not the primary diagnosis.<sup>22</sup> BHCHP estimates indicate that approximately 18 percent of total health care spending for BHCHP enrollees is attributable to substance use disorder treatment. To the extent that average per person spending for the BHCHP population in our study may appear slightly lower than that in previous studies, this may be because our results represent a conservative estimate of that population's higher spending and use.

## Study Results

**DEMOGRAPHICS** Of the 402 BHCHP patients continuously enrolled for three years, the mean age was 52.3 years, and 72.4 percent were male (exhibit 1). In addition, 39.1 percent were white, 36.8 percent were black, and 10.9 percent were Hispanic. The average risk score was 6.5. Most members of this population (98.3 percent) had English as their primary language, 22.4 percent had a disability, and 13.0 percent were veterans. Mean monthly income was \$519. In terms of housing status, 5.2 percent were on the street, 16.9 percent stayed in a shelter, 10.5 percent were doubled up, 3.7 percent lived in transitional housing, 25.1 percent lived in supportive housing, and 34.1 percent lived in housing with no support services. In comparison, the Massachusetts Medicaid population had an average age of 43.5 years and was 33.6 percent male, 60.5 percent white, 11.7 percent black, and 18.2 percent Hispanic. That population's average risk score was 3.2, 80.4 percent reported that English was their primary language, and 24.6 percent had a disability.

**DISEASE BURDEN** Disorders of the joint and respiratory symptoms were two of the leading categories of diagnoses for both groups (exhibit 2).

Other leading categories for both groups included disorders of soft tissues, essential hypertension, and disorders of the back. However, the BHCHP population notably had a higher prevalence of viral hepatitis (37.3 percent) than the general Medicaid population (not shown).

The prevalence of mental health comorbidities was greater in the BHCHP population (exhibit 2). Episodic mood disorders (46.8 percent); anxiety, dissociative, or somatoform disorders (42.5 percent); and major depressive disorder (35.6 percent) were all among the top twenty diagnoses in BHCHP patients and more prevalent among that population than among the Massachusetts Medicaid population.

### EXHIBIT 1

**Characteristics of the study population in the Boston Health Care for the Homeless Program (BHCHP) and the comparison Massachusetts Medicaid population in 2013–15**

Characteristics	BHCHP (n = 402)	Massachusetts Medicaid (n = 18,638)
Mean age, years (SD)	52.3 (7.3)	43.5 (10.4)
Male (%)	72.4	33.6
Female (%)	27.6	66.4
Risk score (SD)	6.5 (8.7)	3.2 (3.9)
Race/ethnicity (%)		
White	39.1	60.5
Black	36.8	11.7
Hispanic	10.9	18.2
Asian	0.0	3.9
Other	3.0	0.8
Unknown	10.2	4.9
Primary language (%)		
English	98.3	80.4
Spanish	1.7	8.1
Other or unknown	0.0	11.5
Disability (%)	22.4	24.6
Monthly income (\$)		— <sup>a</sup>
Mean (SD)	519 (569)	
25th percentile	0	
50th percentile	700	
75th percentile	750	
Housing status (%)		— <sup>a</sup>
Street	5.2	
Shelter	16.9	
Doubling up	10.5	
Transitional housing	3.7	
Supportive housing	25.1	
Housing without support services	34.1	
Unknown	4.5	
Veteran status (%)	13.0	— <sup>a</sup>

**SOURCE** Authors' analysis of data for 2013–15 from the BHCHP and Massachusetts Medicaid. **NOTES** The BHCHP population comprised patients affiliated with the program who were homeless or had unstable housing. The Massachusetts Medicaid population comprised general Medicaid enrollees in Massachusetts, excluding people with the *International Classification of Diseases*, Ninth Revision, code for homelessness. This exhibit shows characteristics of the people who were continuously enrolled in either BHCHP or Medicaid. The risk score (with 1.0 denoting average population risk) was calculated using the Verisk Health Diagnostic Cost Group model, which used age, sex, and diagnoses. SD is standard deviation. <sup>a</sup>The Medicaid data did not include information on income, housing status, or veteran status.

EXHIBIT 2

Most common clinical diagnoses among the study population in the Boston Health Care for the Homeless Program (BHCHP) and comparison Massachusetts Medicaid population in 2013–15

BHCHP		Massachusetts Medicaid	
Diagnosis	%	Diagnosis	%
Other and unspecified disorders of joint	62.2	Respiratory system symptoms and other chest symptoms	51.4
Other disorders of soft tissues	59.2	General symptoms	50.0
Respiratory system symptoms and other chest symptoms	59.2	Other and unspecified disorders of joint	47.4
General symptoms	58.5	Other and unspecified disorders of back	43.0
Essential hypertension	53.0	Other disorders of soft tissues	41.3
Episodic mood disorders	46.8	Anxiety, dissociative and somatoform disorders	39.9
Other and unspecified disorders of back	46.5	Disorders of lipid metabolism	37.9
Anxiety, dissociative, or somatoform disorders	42.5	Other symptoms involving abdomen and pelvis	37.8
Symptoms involving digestive system	40.3	Essential hypertension	35.9
Other symptoms involving abdomen and pelvis	39.3	Nondependent abuse of drugs	32.1
Symptoms involving head and neck	38.3	Symptoms involving head and neck	30.3
Viral hepatitis	37.3	Symptoms involving skin and other integumentary tissue	29.6
Disorders of refraction and accommodation	37.3	Symptoms involving digestive system	29.6
Symptoms involving skin and other integumentary tissue	37.1	Depressive disorder, not elsewhere classified	27.5
Major depressive disorder, single episode, unspecified	35.6	Episodic mood disorders	27.3
Injury other and unspecified	35.6	Overweight, obesity, and other hyperalimentation	26.8
Nonspecific findings on examination of blood	33.6	Diseases of esophagus	25.3
Diseases of esophagus	31.3	Disorders of refraction and accommodation	24.0
Adjustment reaction	31.1	Symptoms involving urinary system	22.3
Diabetes mellitus	29.9	Nonspecific findings on examination of blood	21.4

**SOURCE** Authors' analysis of data for 2013–15 from the BHCHP and Massachusetts Medicaid. **NOTES** The diagnoses are from *International Classification of Diseases, Ninth Revision (ICD-9)*, codes. Sample sizes are in exhibit 1.

**UNADJUSTED SPENDING TRENDS** In the BHCHP population, total health care spending per person averaged \$15,256 in 2013, which was roughly 2.2 times more than the \$7,013 per person in the Massachusetts Medicaid population (exhibit 3). In 2015 total spending per person had grown to \$21,598 in the BHCHP population, a 42 percent increase from 2013. This amount was about 2.7 times greater than the total spending of \$8,080 per person in the Massachusetts Medicaid population in 2015 (a 15 percent increase from 2013). In a sensitivity analysis that omitted behavioral health claims from the Massachusetts Behavioral Health Partnership from each year, the comparison was similar (see online appendix A).<sup>26</sup> Since Massachusetts Behavioral Health Partnership claims were available for 2014–15 only, we conducted this sensitivity analysis to ensure that the increase was not explained by the absence of behavioral health claims in 2013.

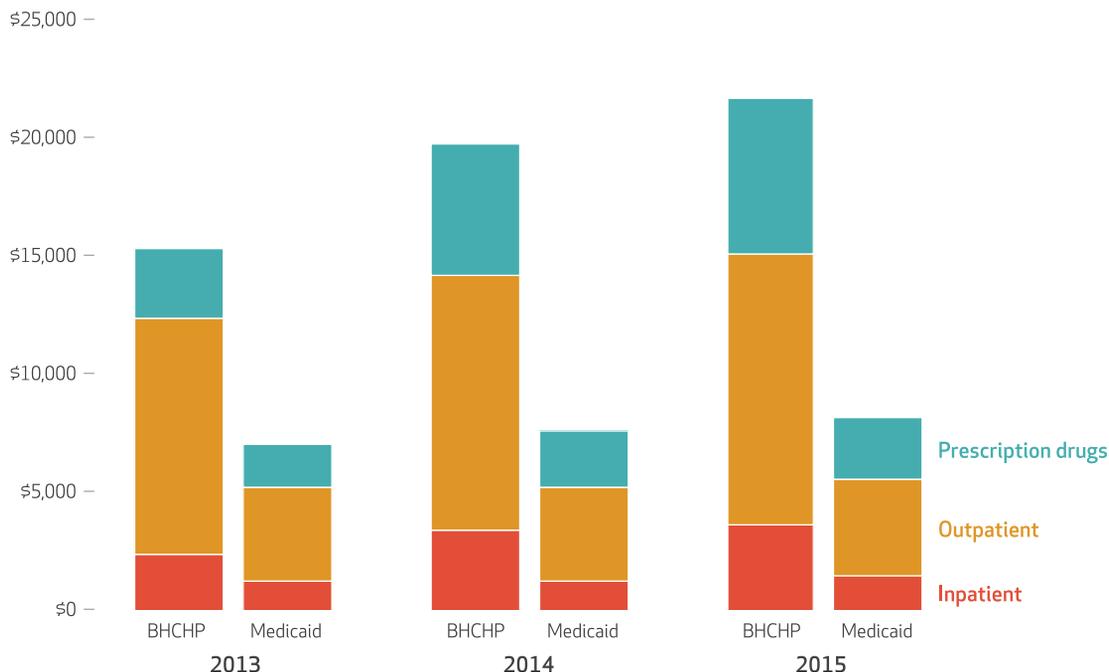
This increase in BHCHP spending was driven most by growth in prescription drug spending, which rose from \$2,970 per person in 2013 to \$6,564 per person in 2015—an increase of 121 percent (exhibit 3). There was a more modest 42 percent increase from \$1,838 per person in 2013 to \$2,607 per person in 2015 among the

Massachusetts Medicaid population. In 2015 BHCHP prescription drug spending was roughly 2.5 times greater than that in the Massachusetts Medicaid population, up from about 1.6 times greater in 2013. This is partly explained by the increase in spending on hepatitis C treatments—such as ledipasvir-sofosbuvir (Harvoni), which Massachusetts Medicaid began to cover in December 2013—consistent with the fact that the BHCHP population had a higher prevalence of viral hepatitis than the Massachusetts Medicaid group did. Overall, the BHCHP population incurred no spending on ledipasvir-sofosbuvir in 2013 but \$2,700 per person in 2015, totaling \$1.1 million in this sample. In contrast, Massachusetts Medicaid spent nothing on ledipasvir-sofosbuvir in 2013, but \$300 per person in 2015, amounting to \$5.5 million in this sample (data not shown).

Outpatient spending in the BHCHP population grew 15 percent from \$9,947 per person in 2013 to \$11,444 per person in 2015, and inpatient spending increased 53 percent from \$2,339 per person in 2013 to \$3,590 per person in 2015 (exhibit 3). By comparison, outpatient spending in the Massachusetts Medicaid population grew less than 1 percent from \$3,977 per

**EXHIBIT 3**

**Average annual health care spending per person continuously enrolled in the Boston Health Care for the Homeless Program (BHCHP) or Massachusetts Medicaid in 2013–15, by type of spending**



**SOURCE** Authors' analysis of data for 2013–15 from the BHCHP and the Massachusetts Medicaid program. **NOTES** Psychiatry claims from the Massachusetts Behavioral Health Partnership are included in outpatient, inpatient, and prescription drug spending data though only for 2014 and 2015, since the partnership's claims data were not available for the period before September 2013. Spending is reported in 2015 US dollars.

person in 2013 to \$3,993 per person in 2015, and inpatient spending increased 24 percent from \$1,198 per person in 2013 to \$1,480 per person in 2015. Outpatient and inpatient spending among the BHCHP cohort were roughly 2.9 and 2.4 times greater, respectively, than those in the Massachusetts Medicaid comparison population in 2015.

**SPENDING BY CATEGORY** On average across the three years, people in the BHCHP population incurred unadjusted spending of \$18,764 per person per year—roughly 2.5 times more than the per person per year of spending of \$7,561 in the comparison Massachusetts Medicaid population (exhibit 4). When we adjusted for age, sex, race/ethnicity, language, and disability status, this amounted to a difference of \$9,825 per person per year. When we additionally controlled for the risk score, this difference was \$4,387.

Compared to the Massachusetts Medicaid population, the BHCHP population incurred about 2.2 times more unadjusted spending on prescription drugs (\$5,089 versus \$2,272). The adjusted difference was \$2,236 without and \$1,358 with the risk score controlled for. The BHCHP population incurred 2.4 times more unadjusted spending of on inpatient care (\$3,106 versus

\$1,307)—an adjusted difference of \$1,362 without controlling for the risk score. When we additionally adjusted for risk, the difference was  $-\$1,035$ . The BHCHP population incurred 2.7 times more unadjusted spending on outpatient care (\$10,568 versus \$3,982). The adjusted difference was \$6,227 without and \$4,064 with the risk score controlled for.

Within outpatient care, the BHCHP population incurred more unadjusted spending on emergency department visits (\$437 versus \$279 per person per year). The adjusted difference was \$191 without and \$72 with the risk controlled for. The BHCHP population, which often transitions through supportive housing with clinician home visits, incurred more spending on home visits, a defined subcategory of the Berenson-Eggers Type of Service classification system (\$2,224 versus \$1 per person per year), with adjusted differences that were similar and statistically significant.

Spending on evaluation and management for psychiatry was lower in the BHCHP population than in the Massachusetts Medicaid comparison group (unadjusted \$87 versus \$246, with adjusted differences of  $-\$65$  without risk controlled for and  $-\$90$  with risk controlled for). Spending

EXHIBIT 4

Average annual health care spending and use per person continuously enrolled in the Boston Health Care for the Homeless Program (BHCHP) or Massachusetts Medicaid in 2013–15, by category of service

	BHCHP	Medicaid	Ratio of BHCHP to Medicaid	Adjusted difference	
				With risk score	Without risk score
<b>SPENDING (AVERAGE PER PERSON PER YEAR)</b>					
Total <sup>a</sup>	\$18,763.50	\$7,560.73	2.48	\$4,386.96***	\$9,825.28****
Inpatient	3,105.89	1,306.68	2.38	-1,035.45*	1,362.14
Outpatient <sup>b</sup>	10,568.34	3,981.87	2.65	4,064.23****	6,227.11****
Evaluation and management					
Office visits	773.64	820.36	0.94	-377.97****	-172.36
Hospital outpatient visits	250.98	107.65	2.33	-91.53**	98.70
Emergency department visits	436.63	278.59	1.57	72.13	190.84
Home visits	2,223.52	1.20	1,859.48	2,138.67****	2,252.69***
Nursing home visits	3.67	2.29	1.60	-5.57	-0.54
Psychiatry visits <sup>c</sup>	87.27	245.62	0.36	-89.51****	-65.26***
Other specialist or consult visits	94.07	73.63	1.28	-25.33	-9.82
Procedures	456.96	705.43	0.65	-836.26****	-357.35***
Imaging	445.56	611.76	0.73	-502.42****	-279.90***
Tests	283.28	420.17	0.67	-317.85****	-179.36****
Durable medical equipment	101.14	74.18	1.36	-53.19	6.41
Other <sup>d</sup>	422.02	179.48	2.35	-23.86	189.58
Exceptions or unclassified <sup>e</sup>	5,000.04	462.59	10.81	4,185.43****	4,562.26****
Prescription drugs	5,089.27	2,272.18	2.24	1,358.18	2,236.03*
<b>USE (AVERAGE VOLUME PER PERSON PER YEAR)</b>					
Inpatient (no. of admissions)	0.34	0.14	2.32	-0.04	0.17*
Outpatient <sup>b</sup>					
Evaluation and management					
Office visits	7.88	8.43	0.93	-2.83***	-0.96
Hospital outpatient visits	2.90	0.83	3.50	0.10	1.79**
Emergency department visits	4.65	1.76	2.64	2.59***	3.31***
Home visits	4.34	0.01	387.35	4.16****	4.39***
Nursing home visits	0.04	0.03	1.29	-0.09*	-0.02
Psychiatry visits <sup>c</sup>	1.45	3.58	0.40	-1.13****	-0.79**
Other specialist or consult visits	1.24	1.09	1.14	-0.19	-0.05
Procedures	5.33	4.80	1.11	-2.30****	0.05
Imaging	8.36	4.81	1.74	1.73*	3.72**
Tests	21.13	16.61	1.27	-0.97	4.91
Durable medical equipment	1.26	1.03	1.22	-0.68*	-0.04
Prescription drugs (no. of scripts)	63.09	34.75	1.82	16.54***	24.06****

**SOURCE** Authors' analysis of data for 2013–15 data from the BHCHP and Massachusetts Medicaid. **NOTES** Spending is reported in 2015 US dollars. Sample sizes are in exhibit 1. Significance refers to differences between the program populations, accounting for the family-wise error rate (multiple inference adjustment). Standard *p* values that were not adjusted for multiple inference, which signaled a higher degree of significance, are not shown. <sup>a</sup>Inpatient, outpatient, and prescription drug spending. <sup>b</sup>Outpatient services are largely organized by the Berenson-Eggers Type of Service classification. <sup>c</sup>Behavioral health services, defined as psychiatry visits per the Berenson-Eggers Type of Service classification system, were compared in 2014 and 2015 only, since claims data from the Massachusetts Behavioral Health Partnership were not available for the period before September 2013. <sup>d</sup>Includes ambulance, chiropractic, enteral and parenteral, chemotherapy, other drugs, vision, hearing and speech services, and influenza immunization. Use is not shown because the category had multiple types of care that could not be counted using a common unit. <sup>e</sup>Includes other services in the Medicare and non-Medicare fee schedules, local codes, and undefined codes. Use is not shown, as explained for the "other" category. \**p* < 0.1 \*\**p* < 0.05 \*\*\**p* < 0.01 \*\*\*\**p* < 0.001

for the two groups was not significantly different for other specialist or consult visits (\$94 versus \$74, with adjusted differences of -\$10 and -\$25). The BHCHP population incurred less spending than the comparison group on procedures (\$457 versus \$705, with adjusted differences of -\$357 and -\$836), imaging (\$446 versus \$612, with adjusted differences of -\$280 and -\$502), and tests (\$283 versus \$420, with adjusted differences of -\$179 and -\$318).

**USE BY CATEGORY** In unadjusted terms, the

BHCHP population used more of every category of service except psychiatry evaluation and management visits (1.45 versus 3.58 visits per person per year, with adjusted differences of -0.79 without controlling for risk and -1.13 controlling for risk) and office visits (7.88 versus 8.43, with adjusted differences of -0.96 and -2.83).

Notably, people in the BHCHP population visited emergency departments an unadjusted 4.65 times per person per year, compared to 1.76 visits in the comparison population (adjusted dif-

ferences of 3.31 and 2.59). On average, people in the BHCHP population were admitted to the hospital an unadjusted 0.34 times per year, compared to 0.14 in the comparison group, with adjusted differences of 0.17 ( $p = 0.08$ ) and  $-0.04$  ( $p = 0.67$ ) (exhibit 4).

## Discussion

This cohort study provides novel evidence of substantial differences in health care spending and use among a population whose members experienced episodes of homelessness and were attributed to a precursor ACO, compared to a similar Medicaid population without unstable housing. Average annual unadjusted total spending for people who experienced episodes of homelessness was 2.5 times greater than that among the comparison population. Unadjusted spending was 2.4 times greater for inpatient spending, 2.7 times greater for outpatient spending, and 2.2 times greater for prescription drug spending. Furthermore, health care spending in the BHCHP population was roughly 3.3 times greater than the average national Medicaid spending per enrollee of \$5,736 in 2014.<sup>27</sup>

Adjusted differences in spending between the BHCHP and comparison cohorts were consistent in direction with the unadjusted differences among most segments of spending, but the magnitudes of the adjusted differences were sensitive to adjustment for the risk score. When risk was controlled for, the extent to which the BHCHP population incurred more spending than the comparison Medicaid population was generally attenuated. This suggests that the risk score is meaningfully correlated with unstable housing and that adjusting for risk partially explains away the differences in spending that are otherwise likely attributable to unstable housing.

Differences in adjusted spending between the BHCHP and comparison cohorts were driven by differences in outpatient rather than inpatient spending. One striking difference in outpatient spending between the two groups was home visits. A core function of the BHCHP is to provide home visits for patients after they transition into housing. This includes addressing patients' medical, behavioral health, and case management needs in a home setting rather than a clinic setting. These home visits are billable as Medicaid evaluation and management visits. Thus, home visits likely help explain why outpatient spending in the BHCHP group exceeded spending in a similar control group that did not experience housing instability, as opposed to office visits, which incurred less spending in the BHCHP group. Of note, the BHCHP cohort also had significantly more emergency department visits.

However, the difference in spending on these visits was not significant after adjustment, in part because of higher variance around the mean in emergency department spending. The same was true for prescription drug spending. The BHCHP cohort also received more imaging (though spending less on it)—likely as a result of differences in the types of imaging received.

Our study helps address a major challenge in studying health care for unstably housed populations: the unstable enrollment of homeless people in any insurance program. People experiencing homelessness often lose health insurance because of frequent address changes that prevent them from receiving eligibility re-determination paperwork, inability to work or pay premiums, and other life challenges that make it difficult to meet the requirements for maintaining coverage.<sup>5,24</sup> At the same time, studying people who were continuously enrolled in the BHCHP and who had episodes of homelessness may have rendered our results less generalizable to the broader homeless population. Indeed, continuously enrolled people differed on sociodemographic dimensions from people not continuously enrolled (appendix B).<sup>26</sup> However, our comparison at the monthly level of people in the program who were and were not continuously enrolled in terms of spending demonstrated broadly similar patterns (appendix C).<sup>26</sup>

To our knowledge, this is the first study to provide a detailed analysis of health care spending and use based on longitudinal claims data in a continuously enrolled population whose members experienced episodes of homelessness, compared to a general population of Medicaid enrollees with no evidence of experiencing homelessness. Our unadjusted results were consistent with previous studies' findings of high rates of inpatient, outpatient, and emergency department visits among the homeless population,<sup>5-17</sup> though most previous studies did not have the granularity to look at the other types of services (such as specialty visits, procedures, imaging, and tests) that we examined. The association between homelessness and intensive health care use is thought to be due both to the high burden of co-occurring medical, psychiatric, and substance use disorders and to social factors such as challenges with health literacy, difficulty adhering to medication regimens, lack of transportation, lack of child care, perceived discrimination in health care settings, and cognitive impairment.<sup>15,28</sup> Our study built on two prior studies that also used claims data for BHCHP patients. The first showed that emergency department use among homeless people remained high even after the expansion of health

insurance in Massachusetts, which included both a Medicaid expansion in the early 1990s and a larger insurance expansion involving subsidized private plans in 2006.<sup>5</sup> The other showed that homeless people had greater spending and use relative to the Medicaid population, though it used only one year of data.<sup>8</sup>

Notably, our study found fewer psychiatric office visits in the BHCHP population than in the comparison group. Though comparisons of psychiatric service use in homeless and nonhomeless populations are few, our results are broadly consistent with a prior study suggesting that homeless patients used fewer outpatient services than a nonhomeless population did.<sup>7</sup> Possible explanations include reluctance to establish longitudinal relationships with providers because of extensive trauma histories, difficulty engaging with traditional clinic models that rely on patients to show up for regular appointments despite many other survival demands,<sup>24</sup> or an inadequate supply of psychiatric prescribers for the homeless population.

These findings from a precursor to the Massachusetts Medicaid ACO program may help improve the design of alternative payment models for vulnerable populations. ACO contracts and alternative payment models have two key economic parameters over which payers and providers typically negotiate: the size of the budget (or spending target) and its growth rate. Our

results show that total Medicaid spending for people experiencing episodes of homelessness can average over \$4,300 per person per year more than spending for Medicaid enrollees with no evidence of experiencing homelessness—even after risk is adjusted for. Thus, budgets for provider organizations that care for similar unstably housed populations may need to be further adjusted to allow the organizations to care for such populations in a sustainable manner. Using risk adjustment for social determinants of health is one possible way to account for the unique needs of populations with unstable housing. Massachusetts Medicaid began adjusting capitation rates for homelessness based on a 2016 analysis that estimated the incremental costs of caring for people with housing instability to be approximately \$550 per person per year.<sup>29,30</sup> In light of the spending differences found in our analysis between people who did and did not experience housing instability (\$4,387 per person per year when adjusted for all covariates), this \$550 base adjustment reflects only about one-eighth of the spending difference we observed.

In conclusion, these novel data improve understanding of health care spending and use among people with unstable housing and thus may inform the design of Medicaid alternative payment models in the era of accountable care. ■

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## NOTES

- 1 Taylor L. Health Policy Brief: housing and health: an overview of the literature. *Health Affairs* [serial on the Internet]. 2018 Jun 7 [cited 2019 Dec 13]. Available from: <https://www.healthaffairs.org/doi/10.1377/hpb20180313.396577/full/>
- 2 Lewis VA, Larson BK, McClurg AB, Boswell RG, Fisher ES. The promise and peril of accountable care for vulnerable populations: a framework for overcoming obstacles. *Health Aff (Millwood)*. 2012;31(8):1777–85.
- 3 Seifert RW, Love KA. What to know about ACOs: an introduction to MassHealth accountable care organizations [Internet]. Shrewsbury (MA): Commonwealth Medicine, University of Massachusetts Medical School; 2018 Jul 26 [cited 2019 Dec 18]. Available from: <https://commmed.umassmed.edu/our-work/2018/07/26/what-know-about-acos-introduction-masshealth-accountable-care-organizations>
- 4 Center for Health Care Strategies, Inc. Medicaid accountable care organizations: state update [Internet]. Hamilton (NJ): CHCS; 2018 Feb [cited 2019 Dec 13]. (Fact Sheet). Available from: <https://www.chcs.org/resource/medicaid-accountable-care-organizations-state-update/>
- 5 Lin WC, Bharel M, Zhang J, O'Connell E, Clark RE. Frequent emergency department visits and hospitalizations among homeless people with Medicaid: implications for Medicaid expansion. *Am J Public Health*. 2015;105(Suppl 5):S716–22.
- 6 Bharel M, Lin WC, Zhang J, O'Connell E, Taube R, Clark RE. Health care utilization patterns of homeless individuals in Boston: preparing for Medicaid expansion under the Affordable Care Act. *Am J Public Health*. 2013;103(Suppl 2):S311–7.
- 7 Folsom DP, Hawthorne W, Lindamer L, Gilmer T, Bailey A, Golshan S, et al. Prevalence and risk factors for homelessness and utilization of mental health services among 10,340 patients with serious mental illness in a large public mental health system. *Am J Psychiatry*. 2005;162(2):370–6.
- 8 Raven MC, Tieu L, Lee CT, Ponath C, Guzman D, Kushel M. Emergency

- department use in a cohort of older homeless adults: results from the HOPE HOME Study. *Acad Emerg Med.* 2017;24(1):63–74.
- 9 Moore DT, Rosenheck RA. Factors affecting emergency department use by a chronically homeless population. *Psychiatr Serv.* 2016;67(12):1340–7.
  - 10 Ku BS, Fields JM, Santana A, Wasserman D, Borman L, Scott KC. The urban homeless: super-users of the emergency department. *Popul Health Manag.* 2014;17(6):366–71.
  - 11 Lebrun-Harris LA, Baggett TP, Jenkins DM, Sripipatana A, Sharma R, Hayashi AS, et al. Health status and health care experiences among homeless patients in federally supported health centers: findings from the 2009 patient survey. *Health Serv Res.* 2013;48(3):992–1017.
  - 12 Buck DS, Brown CA, Mortensen K, Riggs JW, Franzini L. Comparing homeless and domiciled patients' utilization of the Harris County, Texas public hospital system. *J Health Care Poor Underserved.* 2012;23(4):1660–70.
  - 13 Kushel MB, Perry S, Bangsberg D, Clark R, Moss AR. Emergency department use among the homeless and marginally housed: results from a community-based study. *Am J Public Health.* 2002;92(5):778–84.
  - 14 D'Amore J, Hung O, Chiang W, Goldfrank L. The epidemiology of the homeless population and its impact on an urban emergency department. *Acad Emerg Med.* 2001;8(11):1051–5.
  - 15 Kushel MB, Vittinghoff E, Haas JS. Factors associated with the health care utilization of homeless persons. *JAMA.* 2001;285(2):200–6.
  - 16 Weinreb L, Goldberg R, Perloff J. Health characteristics and medical service use patterns of sheltered homeless and low-income housed mothers. *J Gen Intern Med.* 1998;13(6):389–97.
  - 17 Amato S, Nobay F, Amato DP, Abar B, Adler D. Sick and unsheltered: homelessness as a major risk factor for emergency care utilization. *Am J Emerg Med.* 2019;37(3):415–20.
  - 18 Commonwealth of Massachusetts, Executive Office of Health and Human Services, Office of Medicaid. MassHealth: Section 1115 demonstration amendment [Internet]. Boston (MA): Commonwealth of Massachusetts; 2013 Jun 4 [cited 2019 Dec 13]. p. 11. Available from: <https://www.mass.gov/files/documents/2016/07/ss/1115-demonstration-amendment-request-6-4-13.pdf>
  - 19 O'Connell JJ. Stories from the shadows: reflections of a street doctor. Boston (MA): Boston Health Care for the Homeless Program; 2015.
  - 20 Hileman G, Steele S. Accuracy of claims-based risk scoring models [Internet]. Schaumburg (IL): Society of Actuaries; [cited 2019 Dec 18]. Available from: <https://www.soa.org/globalassets/assets/Files/Research/research-2016-accuracy-claims-based-risk-scoring-models.pdf>
  - 21 CMS.gov. Berenson-Eggers Type of Service (BETOS) codes [Internet]. Baltimore (MD): Centers for Medicare and Medicaid Services; [cited 2019 Dec 13]. Available from: <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MedicareFeeforSvcPartsAB/downloads/betosdescodes.pdf>
  - 22 Confidentiality of Substance Use Disorder Patient Records. 42 C.F.R. Part 2 (2019).
  - 23 Westfall PH, Young SS. Resampling-based multiple testing: examples and methods for *p*-value adjustment. New York (NY): John Wiley and Sons; 1993.
  - 24 Ku BS, Scott KC, Kertesz SG, Pitts SR. Factors associated with use of urban emergency departments by the U.S. homeless population. *Public Health Rep.* 2010;125(3):398–405.
  - 25 Geruso M, Layton T. Upcoding: evidence from Medicare on squishy risk adjustment [Internet]. Cambridge (MA): National Bureau of Economic Research; [revised 2018 Apr; cited 2019 Dec 13]. (NBER Working Paper No. 21222). Available from: <https://www.nber.org/papers/w21222.pdf>
  - 26 To access the appendix, click on the Details tab of the article online.
  - 27 Henry J. Kaiser Family Foundation. Medicaid spending per enrollee (full or partial benefit) [Internet]. San Francisco (CA): KFF; [cited 2019 Dec 13]. Available from: <https://www.kff.org/medicaid/state-indicator/medicaid-spending-per-enrollee>
  - 28 Hwang SW, Chambers C, Chiu S, Katic M, Kiss A, Redelmeier DA, et al. A comprehensive assessment of health care utilization among homeless adults under a system of universal health insurance. *Am J Public Health.* 2013;103(Suppl 2):S294–301.
  - 29 Commonwealth of Massachusetts, Executive Office of Health and Human Services. MassHealth risk adjustment model, social determinants of health [Internet]. Boston (MA): Commonwealth of Massachusetts; 2016 Oct 14 [cited 2019 Dec 13]. p. 14. Available from: <https://www.mass.gov/files/documents/2017/11/03/1610-risk-adjustment-open-public-meeting.pdf>
  - 30 Ash AS, Mick E. UMass risk adjustment project for MassHealth payment and care delivery reform: describing the 2017 payment model [Internet]. Worcester (MA): University of Massachusetts; 2016 Oct 11 [cited 2020 Jan 8]. Available from: <https://www.mass.gov/files/documents/2017/11/07/1610-umass-modeling-sdh-summary-report.pdf>