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SPECIAL ISSUE: LINKING VA AND NON-VA DATA TO ADDRESS US VETERAN HEALTH SERVICES ISSUES

Costs Associated with Health Care Services Accessed through VA and in the Community through Medicare for Veterans Experiencing Homelessness

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Objective. To estimate health care utilization and costs incurred by homeless Veterans relative to nonhomeless Veterans and to examine the impact of a VA homelessness program on these outcomes.

Data Sources/Study Setting. Combined Department of Veterans Affairs (VA) administrative and Medicare claims data.

Study Design. Observational study using longitudinal data from Veterans engaged with the VA system and enrolled in Medicare. Veterans with administrative evidence of homelessness at any point during 2006–2010 were matched on period of military service to Veterans with no evidence of homelessness.

Principal Findings. Experience of homelessness was associated with 1.37 (95 percent CI = 1.34–1.40) and 0.16 (95 percent CI = 0.14–0.17) more outpatient encounters per quarter in VA and non-VA settings, respectively, and 1.31 (95 percent CI = 1.30–1.32) and 0.49 (95 percent CI = 0.48–0.49) more inpatient days per quarter in VA and non-VA hospitals, respectively. These were associated with higher costs. Relative to stably housed Veterans less than 65 years of age, those enrolled in a VA homelessness program had 94.4 percent (95 percent CI = 90.7 percent–98.1 percent) more VA outpatient visits but 5.5 percent (95 percent CI = 3.0 percent–7.9 percent) fewer Medicare outpatient visits.

Conclusions. Homelessness was associated with an increase in VA and Medicare utilization and cost. A VA homelessness program decreased use of Medicare outpatient services.

Key Words. Homelessness, health care utilization and cost, Veterans Affairs, Medicare

The relationship between homelessness and health care cost and utilization has been the subject of many empirical studies as well as a central focus of the Gelberg–Andersen Behavioral Model for Vulnerable Populations (Gelberg, Andersen, and Leake 2000). This model describes determinants of health care utilization based on whether they predispose an individual to greater health care needs, enable individuals to access health services, or affect the need for health care services. Homelessness and elements of housing instability may fall into multiple categories of health care services determinants. For example, Gelberg and Andersen list the length of homelessness and the mode of shelter as predisposing variables, competing needs and concern for personal safety are listed as enabling variables, and both general and condition-specific health are given as examples of need variables.

Using this model as a conceptual framework, a number of studies have documented the impact of homelessness on health care cost and utilization. For instance, several studies have shown that individuals experiencing housing instability are more likely to have an inpatient admission (Martell et al. 1992; Reid, Vittinghoff, and Kushel 2008) and longer inpatient stays (Salit et al. 1998) than those who are stably housed. In addition, homelessness is associated with increased emergency department use (Mandelberg, Kuhn, and Kohn 2000; Kushel et al. 2002; O'Toole et al. 2007). Outpatient encounters, in contrast, have been shown to be less frequent in those facing housing instability (Duchon, Weitzman, and Shinn 1999; Kushel et al. 2006; Reid, Vittinghoff, and Kushel 2008). This negative relationship between outpatient care and homelessness may be due to transportation and scheduling challenges (Gelberg et al. 2002; Kurtz et al. 2005), psychological impediments such as concern about refusal of care (Bunce 2000) or stigmatization (Gelberg

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et al. 2004) from health care providers, or simply because these individuals prioritize other concerns (such as seeking food or shelter) over medical needs (Shortt et al. 2008).

The Department of Veterans Affairs (VA) is the largest provider of health care for homeless individuals in the United States (Peterson et al. 2015). Compared to the general population, US Veterans are at greater risk of homelessness (Peterson et al. 2015). VA's 2009 goal to end Veteran homelessness within five years resulted in an increased emphasis on identifying ways to prevent homelessness from occurring and providing stable housing for Veterans experiencing housing instability. An important VA homeless program is the U.S. Department of Housing and Urban Development and VA Supportive Housing (HUD-VASH) program, which provides vouchers for permanent housing assistance and supportive services to help Veterans maintain housing.

Despite this increased emphasis on identifying and preventing homelessness within the VA, we know of only one other study estimating the health care cost associated with Veteran homelessness. Byrne et al. (2017) examined the impact of the duration of homelessness on health care cost and utilization by comparing these outcomes in Veterans who had experienced short-term vs. long-term homelessness (Byrne et al. 2017). Because of this dearth of literature, little information is available to VA providers and policy makers about health care cost and utilization patterns, either within or outside the VA, among Veterans experiencing homelessness.

VA programs designed to combat homelessness (e.g., HUD-VASH) may act as enabling variables in the Gelberg–Andersen model by influencing health services utilization. Several non-VA studies have demonstrated that housing interventions may impact health care utilization and costs. In a randomized trial of a housing and care management program for homeless adults with chronic medical illnesses, Basu and colleagues found that the intervention led to an increase in outpatient encounters and a decrease in emergency department visits and inpatient days (Basu et al. 2012). In addition, Larimer and colleagues found that health care utilization decreased enough to offset the cost of a housing intervention designed for homeless individuals with severe alcohol problems (Larimer et al. 2009).

To our knowledge, only one previous study has explored the impact of a VA homeless program on VA health care utilization. This study, by Gabrielian and colleagues, used data from a single VA site and focused on the HUD-VASH program (McIntyre et al. 2009). The authors found that, in general,

Veterans participating in HUD-VASH had higher rates of utilization compared to currently homeless Veterans. These results may indicate that individuals receiving housing assistance are simply those with the greatest need, that the HUD-VASH program enables access to health care according to the Gelberg–Andersen model, or possibly both.

This study adds to this previous literature by estimating the health care costs and utilization incurred by Veterans experiencing homelessness relative to a control group of stably housed Veterans. Specifically, we examined cost and utilization outcomes both within the VA, using VA administrative data, and outside the VA, using Medicare claims. We also extend the Gabrielian paper by examining the impact of the HUD-VASH program in several important ways: (1) Our data include Veterans accessing the VA at any facility rather than just one, (2) we include VA health care cost as well as utilization outcomes, and (3) we examine cost and utilization from Medicare data.

METHODS

Study Design and Population

We employed a historical cohort study design and used data from the national VA health care system, which consists of 150 medical centers and over 1,000 outpatient clinics (Montgomery et al. 2014). Our cohort consisted of US Veterans with evidence of homelessness at some point during 2002 to 2014 who were matched on a 1:1 ratio on period of military service to Veterans with no evidence of homelessness. The “period of service” in VA administrative data refers to the war or military conflict in which the Veteran served such as Vietnam and Persian Gulf War. Period of service was chosen as a matching variable as this represents a natural grouping of Veterans at the highest level of having served in the same military “era.” We chose to match only on period of service and to control for other factors in our regression analyses. To ensure availability of data, inclusion criteria, and follow-up from the original cohort of Veterans from 2002 to 2014, we constructed a longitudinal dataset to follow patients from the index date (January 1, 2006) through calendar year 2010 or until death. This dataset included up to 20 quarters of follow-up data for each Veteran with fewer quarters for patients who died during the follow-up period. Veterans were included in our cohort if they had at least one VA encounter 365 days or more prior to the index date to establish a 1-year baseline period during which covariates could be constructed. In addition, Veterans were excluded from our cohort who were not enrolled in Medicare on or prior to

the index date and those with administrative evidence of homelessness prior to the index date.

While the majority of Medicare beneficiaries receive these benefits due to advanced age (over 65), some individuals under age 65 receive Medicare benefits due to disability. We conducted our analyses on the overall Medicare beneficiary cohort as well as separate analyses stratified by over and under age 65.

Institutional Review Board (IRB) approval for this study was obtained through the University of Utah's IRB and the VA Salt Lake City's Office of Research and Development.

Data

Patient Characteristics. We obtained patient demographic characteristics and comorbidities from the VA Corporate Data Warehouse (Fihn et al. 2014), which is a repository for a variety of clinical and administrative VA data.

Homelessness. We identified homelessness among Veterans based on elements from structured VA administrative data that we have used in previous studies (Gundlapalli et al. 2015; Peterson et al. 2015). Veterans were considered homeless if they had any one of the following indicators: (1) an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code of V60.0, which represents "lack of housing," (2) an outpatient stop code indicating receipt of services from a VA Homeless Program (permanent supportive housing and community and hospital-based outreach for Veterans experiencing homelessness), or (3) inpatient treatment specialty codes that indicate admission to a residential program for Veterans experiencing homelessness. For our analysis, we considered the date of the first of these recorded events for any Veteran as the date on which the Veteran was first identified as homeless.

Cost and Utilization. We obtained VA health care cost and utilization data from the Managerial Cost Accounting system, which is an activity-based accounting system within the VA. Physicians and managers report their activities, which are then used to distribute costs from the VA payroll and general ledger. These personnel costs are combined with the costs of intermediate goods to generate the costs for each inpatient and outpatient encounter and are then made available for research purposes. Veterans may see multiple providers or services—called clinic stops—during each outpatient encounter. We

considered each clinic stop on a particular calendar date as part of the same encounter.

Finally, we obtained Medicare claims data from the VA Information Resource Center (VIREC; Hynes et al. 2007). We used payment amounts from Medicare claims as a measure of cost to Medicare for outpatient and inpatient services. We used Medicare Provider and Analysis Review (Med-Par), outpatient, and inpatient files to construct Medicare cost and utilization outcomes.

It is important to note that the VA costs described here are those associated with providing care, while the Medicare costs are payments made to reimburse providers for care. These payment amounts are set based on negotiations between Medicare and the entities providing the care and may not reflect the true costs of care. However, both types of cost are incurred by the US federal government so, while the types of cost may differ, the payer is ultimately the same.

Data Linkage. We linked data from multiple VA databases and multiple Medicare databases to construct our analytical dataset. The linking was done using scrambled Social Security number, which is a unique patient identifier that is present in all of the databases described above. By combining data from VA and Medicare, we were able to characterize the health care cost and utilization associated with homelessness much more broadly than through VA data alone. This unique study was only possible because of a data sharing agreement between the VA and the Centers for Medicare and Medicaid Services that allows VIREC to provide access to all Medicare claims for individuals who receive care in the VA.

Variables

Outcome Variables. The outcome variables for our analyses were measures of the quarterly outpatient and inpatient cost and utilization in the VA and outside the VA. Cost variables were constructed by summing all costs incurred within a quarter and were converted to 2016 US dollars using the Personal Consumption Expenditures price index (Dunn, Grosse, and Zuvekas 2018). Outpatient utilization consisted of the number of outpatient encounters within a quarter. Inpatient utilization consisted of the total number of inpatient days within a quarter.

Independent Variables. The key independent variable in our first set of models was a time-varying indicator for administrative evidence of homelessness.

This measure of housing stability is a predisposing variable in the Gelberg–Andersen model. Because it was a time-varying variable, it was equal to 0 for all quarters prior to the quarter in which the first administrative evidence of homelessness occurred and was equal to 1 in all subsequent quarters.

In the second set of models, this homelessness indicator was expanded into a categorical variable in which Veterans were categorized as having participated in HUD-VASH or not. As described above, the HUD-VASH program would be considered an enabling variable in the Gelberg–Andersen model.

We controlled for additional covariates that could potentially confound the relationship between housing status and cost and utilization outcomes. These included variables that predispose Veterans to health services use such as age, race, and sex; those that enable health services use such as marital status; and those related to health needs such as the Charlson/Elixhauser comorbidity index (Gagne et al. 2011), and both VA and Medicare cost in the 365 days prior to the index date. We also controlled for calendar year as a categorical variable as well as the VA facility at which the encounter closest to the index date occurred as fixed effects to control for potential geographic conditions that may influence both homelessness and health care cost and utilization.

Statistical Analysis

We used multivariable generalized estimating equations (GEE) to perform two-part models to estimate the impact of our key independent variable on health care cost using longitudinal data. We used longitudinal data because our key independent variables were time-varying. The first part of the model, which predicted whether any cost or utilization occurred, used a binomial distribution and a logit link function. And we used a gamma distribution with a log link function for the second part, which modeled the continuous cost, conditional on any positive cost (Mullahy 1998). In what follows, we present the results from the first part as adjusted odds ratios and from the second part as adjusted mean differences generated using the method of recycled predictions. For utilization outcomes, we used GEE models with negative binomial distributions and log link functions.

In the first set of analyses, our key independent variable was an indicator for homelessness. In our second set of analyses, we followed the same approach but our key independent variable took on values of no

homelessness, homelessness but no HUD-VASH participation, and homelessness with HUD-VASH participation.

RESULTS

Patient Characteristics

Our cohort consisted of 111,535 Veterans, 16,961 of whom had evidence of homelessness at some point during the analysis period (Figure S1). Those with evidence of homelessness were more likely to be black (24.9 percent vs. 13.6 percent) and less likely to be married (33.8 percent vs. 54.5 percent) relative to those with no evidence of homelessness (Table S1). Overall, the majority of the Veterans in our cohort were male (94.9 percent).

Unadjusted Cost and Utilization

Figure 1 shows the unadjusted mean cost and utilization per quarter by homeless status. Per quarter, homeless-experienced Veterans had more VA outpatient encounters (7.3 vs. 3.7) but slightly fewer Medicare outpatient encounters (1.9 vs. 2.2). Homeless Veterans were more likely to have a VA outpatient encounter (81.1 percent vs. 68.3 percent) but less likely to have a Medicare outpatient encounter (33.0 percent vs. 41.5 percent) each quarter than those not experiencing homelessness. Individuals experiencing homelessness had higher VA outpatient costs (\$2,759 vs. \$1,387) but slightly lower Medicare outpatient costs (\$510 vs. \$574) on average. In addition, mean inpatient costs were higher for VA (\$4,157 vs. \$1,251) and Medicare (\$1,355 vs. \$859) for homeless Veterans. Homeless Veterans had more inpatient days and were more likely to be admitted for VA and Medicare inpatient stays. Finally, ED costs were higher for homeless Veterans relative to nonhomeless Veterans both in VA (\$175 vs. \$46) and in Medicare (\$174 vs. \$91).

Regression Results

In regression analyses (Table 1), homelessness was associated with an 88.0 percent (95 percent CI = 84.6 percent–91.5 percent) increase in the odds of having a VA outpatient encounter and a 7.2 percent (95 percent CI = 5.9 percent–8.6 percent) increase in the odds of a Medicare outpatient encounter. For those patient-quarters with positive cost, Veterans with evidence of homelessness had \$578 (95 percent CI = \$545–\$611) higher VA outpatient costs. In

Figure 1: (a) Unadjusted Mean Cost by Homeless Status. (b) Unadjusted Mean Number of Emergency Department (ED) Encounters, Inpatient Days, and Outpatient Encounters by Homeless Status. (c) Percentage of Patients with any Inpatient Visit, Emergency Department (ED) Encounter, and Outpatient Encounter by Homeless Status

Table 1: Regression Results—Impact of Homelessness on VA and Medicare Costs

Outcome	Part 1 of 2-Part Model—Binomial Distribution with Logit Link				Part 2 of 2-Part Model—Gamma Distribution with Log Link			
	OR	p-Value	95% CI		Mean Difference	p-Value	95% CI	
			LL	UL			LL	UL
Overall								
VA cost								
VA outpatient	1.880	<.0001	1.846	1.915	\$578	<.0001	\$545	\$611
VA ED	1.971	<.0001	1.934	2.009	\$138	<.0001	\$127	\$149
VA inpatient	2.117	<.0001	2.066	2.169	\$4,244	<.0001	\$2,585	\$5,903
VA total	1.914	<.0001	1.879	1.949	\$2,764	<.0001	\$2,548	\$2,980
Non-VA cost								
Non-VA outpatient	1.072	<.0001	1.059	1.086	\$54	.005	\$16	\$91
Non-VA ED	1.239	<.0001	1.213	1.265	\$139	<.0001	\$112	\$166
Non-VA inpatient	1.465	<.0001	1.428	1.504	\$577	.008	\$149	\$1,006
Non-VA total	1.115	<.0001	1.101	1.129	\$1,272	<.0001	\$1,136	\$1,408
65+								
VA cost								
VA outpatient	1.612	<.0001	1.572	1.653	\$497	<.0001	\$456	\$539
VA ED	2.008	<.0001	1.949	2.070	\$118	<.0001	\$91	\$125
VA inpatient	2.267	<.0001	2.183	2.353	\$8,513	<.0001	\$5,784	\$11,241
VA total	1.640	<.0001	1.600	1.682	\$2,811	<.0001	\$2,500	\$3,123
Non-VA cost								
Non-VA outpatient	1.181	<.0001	1.160	1.202	\$148	<.0001	\$97	\$198
Non-VA ED	1.309	<.0001	1.271	1.347	\$219	<.0001	\$181	\$258
Non-VA inpatient	1.614	<.0001	1.559	1.670	\$1,262	<.0001	\$677	\$1,847
Non-VA total	1.244	<.0001	1.222	1.266	\$1,563	<.0001	\$1,381	\$1,744
<65								
VA cost								
VA outpatient	2.180	<.0001	2.122	2.239	\$644	<.0001	\$594	\$695
VA ED	1.926	<.0001	1.879	1.974	\$151	<.0001	\$136	\$165
VA inpatient	1.979	<.0001	1.916	2.044	\$1,777	.074	−\$174	\$3,728
VA total	2.221	<.0001	2.161	2.282	\$2,437	<.0001	\$2,175	\$2,698
Non-VA cost								
Non-VA outpatient	0.974	.006	0.955	0.992	−\$3	0.914	−\$54	\$49
Non-VA ED	1.165	<.0001	1.129	1.201	\$97	<.0001	\$61	\$133
Non-VA inpatient	1.323	<.0001	1.271	1.377	\$135	0.666	−\$480	\$751
Non-VA total	1.002	.802	0.984	1.022	\$975	<.0001	\$769	\$1,181

Note: Multivariable generalized estimating equations controlled for age, race, sex, marital status, Charlson/Elixhauser comorbidity index, VA cost in the 365 days prior to index date, Medicare cost in the 365 days prior to index date, calendar year, and the VA facility at which the encounter closest to the index date occurred.

OR, odds ratio.

addition, homelessness was associated with a 111.7 percent (95 percent CI = 106.6 percent–116.9 percent) increase in the odds of a VA inpatient admission and a 46.5 percent (95 percent CI = 42.8 percent–50.4 percent) increase in the odds of a non-VA inpatient admission paid for by Medicare. Homeless Veterans had \$4,244 (95 percent CI = \$2,585–\$5,903) and \$577 (95 percent CI = \$149–\$1,006) greater inpatient costs in quarters with positive cost for VA and non-VA admissions, respectively. Homelessness was also associated with increased odds of ED encounters and ED costs for quarters with positive costs. Results were similar both for Veterans over and under 65 years of age. However, homelessness was negatively associated with the odds (OR = 0.974, 95 percent CI = 0.955–0.992) of having any Medicare outpatient costs for Veterans in our cohort under the age of 65.

Table 2 shows the multivariable regression results for outpatient and inpatient utilization outcomes. Homelessness was associated with 1.37 (95 percent CI = 1.34–1.40) and 0.16 (95 percent CI = 0.14–0.17) more outpatient encounters per quarter in VA and non-VA settings, respectively, and 1.31 (95 percent CI = 1.30–1.32) and 0.49 (95 percent CI = 0.48–0.49) more inpatient days per quarter in VA and non-VA hospitals, respectively. Finally, homeless Veterans had 0.08 (95 percent CI = 0.08–0.09) more VA ED visits per quarter and 0.05 (95 percent CI = 0.05–0.06) more Medicare ED visits per quarter relative to nonhomeless individuals. Again, our results were fairly consistent across age-groups.

The results from the regression analyses comparing cost among homeless-experienced Veterans who did and did not use the HUD-VASH program with nonhomeless Veterans are shown in Table 3. From these results, it appears that inpatient and ED cost and utilization (both VA and Medicare) are fairly similar between Veterans with a history of homelessness who are and are not enrolled in HUD-VASH. However, relative to nonhomeless-experienced Veterans, the odds ratio for having any VA outpatient cost for homeless individuals participating in HUD-VASH was 3.685 (95 percent CI = 3.471–3.912), whereas the odds ratio for those not participating in HUD-VASH was much smaller (1.737, 95 percent CI = 1.706–1.768).

For Medicare outpatient cost, the odds ratio for Veterans with evidence of homelessness who did not participate in HUD-VASH (1.161; 95 percent CI = 1.146–1.177) was similar to that for those who participated in HUD-VASH (1.162; 95 percent CI = 1.121–1.204) relative to Veterans without evidence of homelessness. When separated by age-groups, our analyses indicated that, relative to Veterans without evidence of homelessness, the odds of having any Medicare outpatient costs were significantly higher for both

Table 2: Regression Results—Impact of Homelessness on VA and Medicare Utilization

Outcome	Relative Effect				Marginal Effect			
	IRR	p-Value	95% CI		Mean Difference	p-Value	95% CI	
			LL	UL			LL	UL
Overall								
VA utilization								
Outpatient encounters	1.410	<.0001	1.401	1.419	1.37	<.0001	1.34	1.40
ED visits	2.087	<.0001	2.056	2.119	0.08	<.0001	0.08	0.08
Inpatient days	3.509	<.0001	3.485	3.533	1.31	<.0001	1.30	1.32
Non-VA utilization								
Outpatient encounters	1.067	<.0001	0.175	1.075	0.16	<.0001	0.14	0.17
ED visits	1.295	<.0001	0.175	1.315	0.05	<.0001	0.56	0.61
Inpatient days	1.786	<.0001	1.770	1.802	0.49	<.0001	0.48	0.49
65+								
VA utilization								
Outpatient encounters	1.277	<.0001	1.265	1.289	0.74	<.0001	0.71	0.77
ED visits	1.893	<.0001	1.847	1.941	0.05	<.0001	0.05	0.06
Inpatient days	4.292	<.0001	4.245	4.341	1.18	<.0001	1.17	1.20
Non-VA utilization								
Outpatient encounters	1.227	<.0001	1.214	1.240	0.65	<.0001	0.61	0.68
ED visits	1.452	<.0001	1.420	1.485	0.08	<.0001	0.08	0.09
Inpatient days	1.955	<.0001	1.930	1.980	0.71	<.0001	0.70	0.72
<65								
VA utilization								
Outpatient encounters	1.562	<.0001	1.549	1.575	2.21	<.0001	2.17	2.26
ED visits	2.086	<.0001	2.045	2.128	0.10	<.0001	0.10	0.11
Inpatient days	3.110	<.0001	3.080	3.141	1.46	<.0001	1.45	1.48
Non-VA utilization								
Outpatient encounters	1.012	.039	1.001	1.023	0.02	.039	0.00	0.04
ED visits	1.219	<.0001	1.193	1.245	0.04	<.0001	0.03	0.04
Inpatient days	1.686	<.0001	1.663	1.708	0.31	<.0001	0.31	0.32

Note: Multivariable generalized estimating equations controlled for age, race, sex, marital status, Charlson/Elixhauser comorbidity index, VA cost in the 365 days prior to index date, Medicare cost in the 365 days prior to index date, calendar year, and the VA facility at which the encounter closest to the index date occurred.

IRR, incidence rate ratio.

non-HUD-VASH recipients (OR = 1.285, 95 percent CI = 1.262–1.308) and HUD-VASH recipients (OR = 1.311, 95 percent CI = 1.236–1.391) for Veterans over age 65. However, for those less than age 65, those who participated in HUD-VASH had lower odds (OR = 0.908, 95 percent CI = 0.868–0.950) of having any Medicare outpatient cost compared to Veterans without a

Table 3: Regression Results—Impact of Homelessness on VA and Medicare Cost—by HUD-VASH

Outcome	Non-HUD-VASH										HUD-VASH									
	Part 1 of 2-Part Model—Binomial Distribution with Logit Link					Part 2 of 2-Part Model—Gamma Distribution with Log Link					Part 1 of 2-Part Model—Binomial Distribution with Logit Link					Part 2 of 2-Part Model—Gamma Distribution with Log Link				
	OR	p-Value	95% CI			Mean difference	p-Value	LL	UL	UL	OR	p-Value	LL	UL	Mean Difference	p-Value	LL	UL	LL	UL
			LL	UL	UL															
Overall																				
VA cost																				
Outpatient	1.737	<.0001	1.706	1.768		\$535	<.0001	\$501	\$570		3.685	<.0001	3.471	3.912	\$801	<.0001	\$716	\$887		
ED	1.953	<.0001	1.915	1.993		\$136	<.0001	\$125	\$148		2.107	<.0001	2.010	2.210	\$148	<.0001	\$123	\$174		
Inpatient	2.195	<.0001	2.138	2.253		\$4,580	<.0001	\$2,862	\$6,297		2.236	<.0001	2.092	2.389	\$805	.899	—\$3,826	\$5,436		
Total	1.767	<.0001	1.736	1.799		\$2,781	<.0001	\$2,558	\$3,005		3.708	<.0001	3.490	3.939	\$2,348	<.0001	\$1763	\$2,934		
Non-VA cost																				
Outpatient	1.161	<.0001	1.146	1.177		\$55	.005	\$17	\$94		1.162	<.0001	1.121	1.204	—\$158	.006	—\$271	—\$46		
ED	1.395	<.0001	1.363	1.429		\$147	<.0001	\$120	\$175		1.344	<.0001	1.259	1.434	\$55	.160	—\$22	\$132		
Inpatient	1.624	<.0001	1.579	1.670		\$637	.005	\$194	\$1,079		1.580	<.0001	1.459	1.711	—\$218	.751	—\$1,565	\$1,130		
Total	1.203	<.0001	1.187	1.219		\$1,311	<.0001	\$1,174	\$1,451		1.215	<.0001	1.172	1.258	\$793	<.0001	\$364	\$1,221		
65+																				
VA cost																				
Outpatient	1.092	<.0001	1.070	1.115		\$469	<.0001	\$427	\$512		2.094	<.0001	1.948	2.250	\$595	<.0001	\$464	\$726		
ED	2.003	<.0001	1.941	2.066		\$119	<.0001	\$102	\$136		2.070	<.0001	1.893	2.263	\$105	<.0001	\$59	\$151		
Inpatient	2.256	<.0001	2.166	2.350		\$8,627	<.0001	\$5,831	\$11,424		2.426	<.0001	2.140	2.750	\$6,933	.127	—\$1,962	\$15,829		
Total	1.100	<.0001	1.078	1.123		\$2,793	<.0001	\$2,476	\$3,111		2.111	<.0001	1.964	2.269	\$2,502	<.0001	\$1,523	\$3,481		

continued

Table 3. Continued

Outcome	Non-HUD-VASH						HUD-VASH									
	Part 1 of 2-Part Model—Binomial Distribution with Logit Link			Part 2 of 2-Part Model—Gamma Distribution with Log Link			Part 1 of 2-Part Model—Binomial Distribution with Logit Link			Part 2 of 2-Part Model—Gamma Distribution with Log Link						
	OR	p-Value	95% CI		Mean difference	p-Value	LL	UL	OR	p-Value	95% CI		Mean Difference	p-Value	LL	UL
			LL	UL							LL	UL				
Medicare cost																
Outpatient	1.285	<.0001	1.262	1.308	\$159	<.0001	\$107	\$212	1.311	<.0001	1.236	1.391	−\$37	.697	−\$225	\$151
ED	1.509	<.0001	1.460	1.559	\$221	<.0001	\$181	\$260	1.618	<.0001	1.450	1.807	\$194	.007	\$53	\$336
Inpatient	1.755	<.0001	1.691	1.821	\$1,245	<.0001	\$645	\$1,845	1.813	<.0001	1.604	2.049	\$1,515	.169	−\$644	\$3673
Total	1.340	<.0001	1.316	1.364	\$1,578	<.0001	\$1,392	\$1,764	1.420	<.0001	1.340	1.506	\$1,309	<.0001	\$631	\$1,986
<65																
VA cost																
Outpatient	1.977	<.0001	1.923	2.033	\$586	<.0001	\$533	\$639	4.529	<.0001	4.177	4.911	\$983	<.0001	\$867	\$1,099
ED	1.901	<.0001	1.852	1.952	\$148	<.0001	\$133	\$163	2.091	<.0001	1.976	2.214	\$167	<.0001	\$137	\$197
Inpatient	1.993	<.0001	1.927	2.061	\$2,244	.030	\$213	\$4274	1.875	<.0001	1.736	2.025	−\$2,449	.336	−\$7,439	\$2,541
Total	2.020	<.0001	1.964	2.077	\$2,476	<.0001	\$2,201	\$2,750	4.530	<.0001	4.175	4.916	\$2,149	<.0001	\$1,507	\$2,790
Medicare cost																
Outpatient	0.984	.124	0.965	1.004	\$21	.444	−\$33	\$75	0.908	<.0001	0.868	0.950	−\$170	.010	−\$299	−\$40
ED	1.198	<.0001	1.159	1.238	\$106	<.0001	\$69	\$143	1.058	.158	0.978	1.143	\$28	.535	−\$60	\$116
Inpatient	1.343	<.0001	1.287	1.401	\$256	.433	−\$384	\$896	1.188	.001	1.073	1.315	−\$1,015	.238	−\$2,703	\$672
Total	1.014	.165	0.994	1.035	\$1,025	<.0001	\$810	\$1241	0.931	.002	0.891	0.974	\$535	.058	−\$18	\$1,087

Note: Multivariable generalized estimating equations controlled for age, race, sex, marital status, Charlson/Elixhauser comorbidity index, VA cost in the 365 days prior to index date, Medicare cost in the 365 days prior to index date, calendar year, and the VA facility at which the encounter closest to the index date occurred.

OR, odds ratio.

history of homelessness. In addition, conditional on having any Medicare outpatient costs, those costs were \$170 (95 percent CI = \$40–\$299) lower for HUD-VASH recipients compared to Veterans without a history of homelessness. A similar pattern can be seen in Table S2 for VA and Medicare utilization outcomes.

DISCUSSION

Our study found that, following evidence of homelessness in VA data, Veterans utilized more outpatient and inpatient care per quarter than those with no evidence of housing instability. This was true for both VA (1.37 more outpatient encounters and 1.31 more inpatient days) and Medicare outcomes (0.16 more outpatient encounters and 0.49 more inpatient days). In addition, history of homelessness was associated with higher costs per quarter, conditional on having outpatient encounters (\$578 for VA and \$54 for Medicare) or being admitted for an inpatient stay (\$4,244 for VA and \$577 for Medicare). While it is true that individuals experiencing homelessness have a high prevalence of chronic medical conditions and mental health problems (Baggett et al. 2010; Argintaru et al. 2013), our finding of increased cost and utilization was apparent even after controlling for patient comorbidities. This finding is consistent with prior research demonstrating homelessness to be an independent risk factor for adverse health outcomes and increased health services use and is likely explained by the challenges in managing health conditions in a population without stable housing (Morrison 2009; Fazel, Geddes, and Kushel 2014).

We also found that participating in HUD-VASH was associated with an increase in VA outpatient care and a decrease in Medicare outpatient care for Medicare beneficiaries under the age of 65. An increase in VA outpatient services was expected for these individuals as the HUD-VASH program includes the provision of supportive services to not only explore stable housing options but to ensure that Veterans remain stably housed over time. Once these Veterans are connected with HUD-VASH—either through the housing or supportive services—there may be previously unmet health care needs that may be recognized, leading to more health care encounters. To our knowledge, the shift away from non-VA outpatient care associated with HUD-VASH benefits is a new finding. With a greater proportion of outpatient care being received in a VA setting, this evidence suggests that this housing program led to a

greater degree of care coordination for these individuals, which may explain the improvement in clinical outcomes that has been documented in other studies of HUD-VASH (Cheng et al. 2007).

To our knowledge, this is the first study to estimate the cost of health care services for homeless-experienced Veterans within and outside of the VA system. These valuable cost and utilization estimates constructed across multiple health care systems were possible due to our unique linked dataset of VA and Medicare cost and utilization data. These estimates are important for a number of reasons. First, they provide a more complete estimate of the resources involved in the management of homelessness by assessing Veterans' use of multiple health care systems. Understanding how homeless Veterans obtain care outside the VA system is important for VA providers to coordinate care across multiple systems and to optimize patient outcomes. Second, these estimates can be used as inputs to economic analyses that evaluate methods of homelessness prevention or treatment both within and outside the VA. For instance, the excess health care costs estimated here could be combined with the cost of interventions designed to prevent homelessness as well as outcomes in a simulation model to examine the cost-effectiveness of these interventions. Third, they provide insights into the differential impact of a VA homelessness program on health care utilization within the VA health care system and in non-VA health care systems.

While we were able to identify homelessness in structured elements of this data, it is much more difficult to determine when a Veteran's homelessness episode ends. For this reason, our time-varying homelessness variable indicated the beginning of a homelessness episode. Therefore, our results should be interpreted as the quarterly health care costs following a homelessness episode relative to those of individuals who have not experienced homelessness up until that point, rather than as the quarterly health care costs of Veterans who are homeless in the current quarter relative to those who are not homeless in the current quarter.

Our findings are consistent with previous studies examining the impact of homelessness on health care cost and utilization. Using inpatient data over a 5-year period from an academic teaching hospital in Toronto, Canada, Hwang et al. (2011) found that admissions for homeless individuals cost \$2,559 more than those for housed patients (Hwang et al. 2011). These same authors examined health care utilization for a cohort of homeless individuals in Toronto compared to matched controls. In this study, they found that homelessness was associated with substantial increases in outpatient encounters, emergency department visits, and inpatient admissions (Hwang et al. 2013). Finally,

Byrne et al. (2017) used data from the universal homelessness screening protocol administered in the VA to distinguish between Veterans experiencing brief and ongoing episodes of housing instability; those whose housing instability was ongoing incurred \$7,573 greater VA health care costs than those with brief episodes (Byrne et al. 2017). Because this universal screening protocol was introduced in the VA in October 2012, after the timeframe of our study, these data were not available for us to identify Veterans with housing instability.

On the other hand, several studies have found results quite different from ours for outpatient visits. These studies have found that, relative to those with stable housing, individuals who are facing housing instability have fewer outpatient encounters (Duchon, Weitzman, and Shinn 1999; Kushel et al. 2006; Reid, Vittinghoff, and Kushel 2008). One explanation for this finding is that individuals experiencing housing instability face a number of logistical and psychological impediments to seeking health care (Bunce 2000; Gelberg et al. 2002, 2004; Kurtz et al. 2005). Furthermore, routine outpatient encounters for primary care may be offset by emergency department utilization (Tsai, Doran, and Rosenheck 2013; Tsai and Rosenheck 2013; Ku et al. 2014). In addition, fulfilling other needs such as sustenance and safety may take precedence over routine medical care (Shortt et al. 2008). While each of these barriers may exist for the Veterans in our cohort who experienced homelessness, it appears that the health care needs associated with homelessness were sufficient for them to overcome these barriers. The differences between our outpatient results and those from previous studies may be explained by differences in the populations or between the VA and civilian health care systems. Veterans experiencing homelessness have been shown to be more likely to have substance abuse problems than their non-Veteran counterparts (Tessler, Rosenheck, and Gamache 2002) but other studies have found no difference in housing outcomes between these two groups (Tsai, Mares, and Rosenheck 2012). A study by Petrovich found that, among a sample of individuals in a low-demand emergency housing shelter, Veterans were more likely to use general medical services, psychiatric services, and substance abuse services than non-Veterans (Petrovich, Pollio, and North 2014). Given that the use of non-VA services was similar between the two groups, the use of VA services led to higher overall use among Veterans. This indicates that there may be systematic differences in the type or scope of health care services available for homeless individuals within the VA system compared to other health care systems.

Several important limitations to this work are worth noting. First, our measure of homelessness, while making innovative use of structured medical

record data, may not have accurately captured the timing of homelessness. This indicator of homelessness is only evident during an encounter at a VA facility and only after recognized by a VA provider and documented in the Veteran's medical record. In other words, there may be misclassification of a Veteran's homeless status within our cohort if a Veteran sought assistance related to homelessness only outside the VA, there were delays in seeking care at the VA, or if VA providers did not document this homeless event in the VA medical record. In addition, this approach for identifying homelessness that relies on the presence of homelessness indicators in the medical record limits the generalizability of our results to the broader homeless Veteran population. Second, there are likely many important health care costs that occurred outside the VA system that were not captured in our analysis including those paid for by private insurance or Medicaid, by the Veteran out-of-pocket, or through charity, nonprofit, and/or community-based providers such as Health Care for the Homeless sites.

Third, while we controlled for a number of observable characteristics that are present in administrative databases in the VA, it is possible that unobserved confounding remains in our models and leads to biased estimates of the impact of homelessness on health care cost and utilization. Examples of these unmeasured confounders include need variables in the Gelberg–Andersen model such as income, education, and employment levels, which all likely influence both homelessness and health care cost and utilization. It is unclear how the addition of these variables to our statistical model would influence our estimated relationship between homelessness and health care cost and utilization since the direction of the effect of these variables on cost and utilization is also unclear. For example, health care is likely a normal good, which means that, as income rises, utilization should increase. This would predict a positive relationship between income and health care cost. However, low income may also be associated with health care utilization since poor diet, lack of exercise, and physical labor (all of which are more common in individuals with lower income) may all increase the need to utilize health care services. Finally, in our analysis, we classified a Veteran as being homeless in the quarter during which the first administrative evidence of homelessness occurred. This approach may have resulted in misclassification if there was a delay between the actual homelessness event and the administrative evidence. Additionally, it was not possible to identify when homeless individuals returned to stable housing. Because of this, our statistical models attributed quarters in which previously homeless

individuals were, in fact, stably housed as if the individual was still homeless. This likely led to an underestimation of the true effect of homelessness on health care cost and utilization.

In conclusion, using longitudinal data from a cohort of VA users, we examined the association between experience of homelessness and outpatient and inpatient cost and utilization. We performed these analyses using outcomes captured in the VA system using data from the VA's activity-based accounting system and Medicare claims data for services obtained outside the VA system. We found that Veterans who had experienced homelessness incurred greater inpatient and outpatient costs both within and outside the VA health care system relative to their stably housed counterparts. Along with improvements in health and quality of life outcomes, it is possible that efforts to prevent homelessness or shorten the duration of episodes of housing instability could yield health care cost savings. This analysis is the first step in understanding the true cost of caring for homeless Veterans and was possible because of the ability to link VA and Medicare data. Future work should delve deeper into the types of VA and non-VA care that Veterans receive during periods of housing instability to determine whether this care is well coordinated and whether this increased utilization of health care services is associated with improved health outcomes. Additional work is also necessary to identify costs incurred outside the VA system for these individuals. These costs may be associated with health care services not paid for by Medicare or they may be associated with social services provided in the community such as shelters, soup kitchens, and legal aid groups. These estimates of the cost of caring for homeless Veterans can be used, along with detailed data on program costs and rigorous assessments of housing and health outcomes, to conduct economic evaluations of VA Homeless Programs designed to prevent homelessness or to connect Veterans to stable housing as soon as possible once an episode of homelessness has begun.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix SA1: Author Matrix.

Figure S1: Cohort Creation Diagram.

Table S1: Patient Characteristics.

Table S2: Regression Results – Impact of Homelessness on VA and Medicare Utilization – by HUD-VASH.