

2017-05

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Matthew S Mitchell, Casey LK León, Thomas H Byrne, Wen-Chieh Lin, Monica Bharel. 2017.

"Cost of health care utilization among homeless frequent emergency department users.."

Psychological Services, Vol 14(2), May 2017, 193-202. <http://dx.doi.org/10.1037/ser0000113>

<https://hdl.handle.net/2144/22769>

"Downloaded from OpenBU. Boston University's institutional repository."

Cost of Health Care Utilization Among Homeless Frequent Emergency Department Users

Matthew S. Mitchell

Boston Health Care for the Homeless Program

Casey L. K. León

Boston Health Care for the Homeless Program

Thomas H. Byrne

Boston University

Wen-Chieh Lin

University of Massachusetts

Monica Bharel

Massachusetts Department of Public Health

Author Note

Matthew S. Mitchell, Boston Health Care for the Homeless Program. Casey L. K. León, Boston Health Care for the Homeless Program. Thomas H. Byrne, Boston University School of Social Work. Wen-Chieh Lin, Center for Health Policy and Research, University of Massachusetts Medical School. Monica Bharel, Massachusetts Department of Public Health.

Matthew S. Mitchell is now at Central City Concern.

A prior version of this analysis was presented at the National Health Care for the Homeless Conference and Policy Symposium on May 8, 2015 in Washington, D.C. We would like to acknowledge MassHealth for approving data access for this study. This article is solely the responsibility of the authors and does not necessarily reflect the opinions or policies of

MassHealth or the Commonwealth of Massachusetts Executive Office of Health and Human Services.

Correspondence regarding this article should be addressed to Matthew S. Mitchell, Central City Concern, 33 NW Broadway, Portland, OR 97209. E-mail: matthew.mitchell@ccconcern.org.

Abstract

Research demonstrates that homelessness is associated with frequent use of emergency department (ED) services, yet prior studies have not adequately examined the relationship between frequent ED use and utilization of non-ED health care services among those experiencing homelessness. There has also been little effort to assess heterogeneity among homeless individuals who make frequent use of ED services. To address these gaps, the present study used Medicaid claims data from 2010 to estimate the association between the number of ED visits and non-ED health care costs for a cohort of 6,338 Boston Health Care for the Homeless Program primary care patients, and to identify distinct sub-groups of persons in this cohort who made frequent use of ED services based on their clinical and demographic characteristics. A series of gamma regression models found more frequent ED use to be associated with higher non-ED costs, even after adjusting for demographic and clinical characteristics. The results of a latent class analysis used to examine heterogeneity among frequent ED users identified six characteristically distinct sub-groups among these persons, and the subgroup of persons with trimorbid illness had non-ED costs that far exceeded members of all five other subgroups. Study findings reinforce the connection between frequent ED use and high health care costs among homeless individuals suggest that different groups of homeless frequent ED users may benefit from interventions that vary in terms of their composition and intensity.

Keywords: homelessness, health care costs, emergency department utilization, Medicaid

Cost of Health Care Utilization Among Homeless Frequent Emergency Department Users

Frequent users of emergency departments (EDs) consist of a small number of patients who visit the ED a disproportionately large number of times each year (LaCalle & Rabin, 2010). Because EDs are not intended to provide routine care and are not equipped to provide continuity, frequent use of EDs is considered an inefficient and costly use of health care resources (Sandoval et al., 2010).

Persons experiencing homelessness account for a large proportion of frequent ED users—nearly 40% according to one study (Mandelberg, Kuhn, & Kohn, 2000)—leading to a specific interest in understanding the dynamics between frequent ED use and other health care service use in this population (Bharel et al., 2013; Chambers, Chiu, et al., 2013; Ku, Scott, Kertesz, & Pitts, 2010; Kushel, 2001; Lin, Bharel, Zhang, O’Connell, & Clark, 2015; Padgett, Struening, Andrews, & Pittman, 1995). Previous studies show housing instability is independently associated with not having a usual source of care, postponing needed medical care, delaying filling prescriptions, increased ED use, and increased hospitalizations (Kushel, Perry, Bangsberg, Clark, & Moss, 2002; Reid, Vittinghoff, & Kushel, 2008). Findings also show that frequent ED use by homeless persons can be quite costly (Ku et al., 2014). However, existing research on frequent ED use among the homeless population has some key limitations.

Most notably, while studies have examined the relationship between frequent ED use and use of non-ED health services in the overall population, (Hansagi, Olsson, Sjöberg, Tomson, & Göransson, 2001; Ruger, Richter, Spitznagel, & Lewis, 2004) there has been little attempt to date to evaluate this relationship specifically for persons experiencing homelessness. This is an important issue, as frequent ED users are typically assumed to be the most costly users of health care services among the homeless population (Ku et al., 2014), due in part to evidence that they

tend to have more complex medical needs than their counterparts who make less frequent use of the ED (Chambers, Katic, et al., 2013). However, debate remains about whether frequent ED use is a substitute for or a complement of other forms of care (Chambers, Chiu, et al., 2013; Ruger et al., 2004), including outpatient care as well as potentially more expensive forms of care such as extended inpatient hospitalizations. Further research on this topic could help inform whether efforts to provide alternatives to ED use will effectively reduce health care costs. Additionally, there has not been adequate investigation of heterogeneity within the population of homeless frequent ED users, despite recognition of the need for additional research in this vein (LaCalle & Rabin, 2010; Pines et al., 2011; Ruger et al., 2004). Prior studies have sought to identify distinct subgroups of persons in the more general homeless population based on their physical health or behavioral health needs (Aubry, Klodawsky, & Coulombe, 2012; Bonin, Fournier, & Blais, 2009; Tsai, Kaspro, & Rosenheck, 2013) and on patterns of emergency shelter utilization (Kuhn & Culhane, 1998). However, there has not been a similar attempt to identify subgroups among homeless frequent ED users. Identifying distinct subgroups of homeless frequent ED users is important for targeting interventions, especially given that ongoing health care reform efforts under the Affordable Care Act (ACA) have included strategies intended to lower costs and improve health outcomes by reducing overutilization of ED services (Friedman, Saloner, & Hsia, 2015; McClelland et al., 2014).

The aims of this study are threefold: to assess the extent to which more frequent ED use is associated with non-ED health care utilization costs among persons experiencing homelessness; to identify distinct subgroups of homeless persons who make frequent use of ED services based on their demographic and clinical characteristics; and to compare distinct subgroups of homeless frequent ED users with respect to their non-ED health care utilization costs.

In parallel with these aims, we hypothesized that frequent ED use would be associated with higher non-ED utilization costs, that homeless frequent ED users have characteristics distinctly different from others, and that sub-groups of frequent ED users with relatively higher burdens of behavioral health disorders and physical disease would incur higher non-ED costs.

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Method

Study Design

We conducted a cross-sectional analysis of merged eligibility, claims, and encounter data from MassHealth (Massachusetts Medicaid) and electronic medical record data from Boston Health Care for the Homeless Program (BHCHP) from calendar year 2010. BHCHP medical record data provided information about the utilization of primary care and other health care services by BHCHP patients. MassHealth claims and encounter data provided a comprehensive summary of health care utilization and complete Medicaid healthcare expenditures, as well as associated diagnoses, in both general medical and behavioral health services sectors and across a broad range of health care settings. However, these data do not systematically capture information about the utilization of residential homeless assistance or other social services by BHCHP patients. MassHealth data also provided demographic characteristics including member age, sex, disability status, and Medicare enrollment. The study was approved by the institutional review boards at Boston University Medical Center Institutional Review Board, the University of Massachusetts Medical School, and Harvard School of Public Health.

Study Setting and Sample

BHCHP was established in 1985 under a Robert Wood Johnson Foundation Grant to improve access to high quality medical care to homeless individuals in Boston. The program is a federally qualified community health center serving individuals and families sleeping on the

street, staying in emergency shelters, or doubled-up with family or friends, as well as those who subsequently transition into housing. BHCHP patients are seen for a combination of urgent care, episodic care, chronic disease management, and preventative health care. Details of BHCHP have been reported elsewhere (O'Connell et al., 2010).

The linkage of BHCHP and MassHealth data enabled the identification of the study cohort. This cohort included all BHCHP patients ages 18 years and older with Medicaid coverage in 2010, which is the only year for which full data was provided by MassHealth. Of 6,846 patients whom BHCHP records indicated were potential MassHealth recipients in 2010, we excluded 343 patients who were not eligible for MassHealth. We also excluded nine BHCHP patients who were enrolled in MassHealth managed care programs, because we did not have access to health care utilization records for those in managed care programs. Additionally, 106 patients under the age of 18 were excluded from the analysis, resulting in a final analytic sample of 6,388 patients. The cohort of BHCHP primary care patients included in this study was predominantly male (71%), largely comprised of non-Hispanic whites (44%) and African Americans (32%), with 68% having any mental illness, 60% having any substance use disorder, and 48% having co-occurring mental illness and substance use disorders. A total of 1,973 individuals (31%) had no ED visit in 2010; 1,144 individuals (18%) had one ED visit; 1,283 individuals (20%) had two or three ED visits; and 1,988 individuals (31%) had four or more ED visits. Additional details on the characteristics of this cohort are provided elsewhere (Bharel et al., 2013).

Measures

The primary measures of interest were the number of ED visits and the costs of non-ED service use. We constructed two measures of ED use. Both of these measures were categorical

rather than continuous measures, which is in alignment with how ED use measures have been operationalized in the majority of prior studies of ED use among the homeless population (e.g. (Kushel et al., 2002; Mandelberg et al., 2000; Tsai, Doran, & Rosenheck, 2013). In following the approach used by Kushel et al. (2002) the first measure grouped ED use into four categories: no visit, one visit, two or three visits, and four or more visits in calendar year 2010. The second was a dichotomous measure of frequent ED use, which, in following a commonly used threshold for frequent ED use, (Hunt, Weber, Showstack, Colby, & Callahan, 2006; Locker, Baston, Mason, & Nicholl, 2007) was defined as four or more ED visits, also in calendar year 2010. The dataset included aggregate total costs reimbursed by MassHealth in 2010 (i.e., actual MassHealth expenditures, not simply the amount billed) for each patient for ED visits, inpatient medical and behavioral health hospitalizations, outpatient services, primary care visits, medical detoxification admissions, skilled nursing and long term care admissions, as well as pharmacy use. To assess the relationship between ED visits and non-ED service costs, we created separate measures for the cost of ambulatory care, which included outpatient services and primary care visits; inpatient medical and behavioral health hospitalizations; pharmacy services; and all other non-ED services, which included long-term care, detoxification and addiction treatment, psychiatric crisis intervention, laboratory services, transportation, durable medical equipment, and medical respite care. We also created a single continuous non-ED cost variable from the sum of all of these measures. We did not include ED service costs in any of our cost measures as they would be confounded with our key predictor of ED service use

To identify additional factors potentially associated with non-ED costs, we used the Andersen Health Care Utilization model (Andersen, 1995) as a conceptual framework. This model classifies variables associated with health care utilization and expenditures into

predisposing, enabling, and need categories. We included population characteristics as predisposing and enabling factors, and we incorporated disability and disease burden as need factors.

We grouped patient age into four categories: 18–34, 35–49, 50–64, and 65 and older. Sex was coded as male or female. Race and ethnicity were categorized as African American, Asian, Hispanic/Latino, non-Hispanic white, or other/unreported. Insurance coverage was categorized as either MassHealth only or dually eligible for Medicare and MassHealth. Disability status, as determined either by the Social Security Administration or by Massachusetts Disability Evaluation Services, was coded dichotomously.

We used *International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM)* (National Center for Health Statistics, 1980) diagnosis codes in MassHealth claims and encounter data to identify eight chronic physical health conditions (hepatitis C, HIV, cirrhosis, hypertension, asthma or COPD, congestive heart failure, ischemic heart disease, and diabetes) and seven behavioral health conditions (schizophrenia and other psychosis, bipolar disorders, depression, anxiety, other mental illness, alcohol abuse or dependence, and drug abuse or dependence). The *ICD-9-CM* codes for diseases were grouped based on the Clinical Classification Software developed by the Agency for Healthcare Research and Quality (Agency for Healthcare Research and Quality, 2016). We also created two composite behavioral health variables. The first composite variable had four levels: no behavioral health conditions (i.e., neither a mental illness nor a substance use disorder), mental illness with no substance use, substance use with no mental illness, and co-occurring mental illness and substance use. To provide more granularity in the latent class analysis, we used a second composite variable with eight levels: no behavioral health conditions, alcohol use with no mental illness, drug use with no

mental illness, polysubstance use with no mental illness, mental illness with no substance use, co-occurring alcohol use and mental illness, co-occurring drug use and mental illness, and co-occurring polysubstance use and mental illness.

Data Analysis

Statistical analysis proceeded in two phases and all analyses were performed using the R statistical programming language version 3.1.0 (R Core Development Team, 2015). In the first phase of analysis, we assessed the relationship between ED use and non-ED costs. To do so, we conducted initial comparisons of non-ED costs across different levels of ED use with Kruskal-Wallis tests. We then used Dunn's post hoc tests with Bonferroni corrections to make pairwise comparisons. Next, we fit a series of one-part generalized linear regression models with a gamma distribution and log-link to assess the association between non-ED cost and demographic and clinical characteristics in addition to ED use (Diehr, Yanez, Ash, Hornbrook, & Lin, 1999). We used a one-part model due to the small number ($n = 57$, 1%) of study subjects with zero costs. We also fit a parallel series of one-part OLS regression models with a log-transformed cost variable. However, the results of these models did not differ substantively from the gamma regression models. We only report the results of the gamma regression models because these results can be interpreted directly in terms of the original scale of the dependent variable (Buntin & Zaslavsky, 2004). In the series of gamma regression models, the first model included only demographic characteristics as explanatory variables. The second model added the eight physical health conditions, the third model added the four-level composite behavioral health variable, and the fourth model added level of ED use as explanatory variables. To further examine the relationship among non-ED costs, ED use, behavioral health conditions, and physical health conditions we fit an additional gamma regression that included demographics, level of ED use,

the composite four-level behavioral health variable, and an aggregate physical health condition variable, which was constructed as the sum of the number of distinct physical health conditions for each member of the study cohort.

For the second phase of the analysis, we performed latent class analysis (LCA) to identify distinct subgroups among frequent ED users based on age, sex, race and ethnicity, insurance coverage, disability status, the composite eight-level categorical behavioral health measure described above, and dichotomous measures of the eight chronic physical health conditions described above. Thus, the aims of the LCA were to better understand risk profiles for non-ED service use among frequent ED users and then to determine whether specific profiles were associated with higher non-ED service costs. LCA models the relationship among observed variables by assuming one or more unobserved subgroups (latent classes). Individual observations are assigned to latent classes based on the probabilities of belonging to each class, such that individuals with similar values for the set of observed variables will be grouped within the same latent class (McCutcheon, 1987). LCA was performed using R package *poLCA* (Linzer & Lewis, 2011). We chose the number of classes based on the Bayesian information criterion as well as on profiles that reflected clinically meaningful patterns. Finally, we performed Kruskal-Wallis tests to compare measures of non-ED cost across the latent class groups to determine whether non-ED costs vary among subgroups of frequent ED users. We then used Dunn's post hoc tests with Bonferroni corrections to make pairwise comparisons among the classes.

Results

Relationship Between Non-ED Costs and ED Use

The Kruskal-Wallis tests found statistically significant differences in costs among levels of ED use for ambulatory care, $H(3) = 363.8, p < 0.001$; medical hospitalizations, $H(3) = 601.2,$

$p < 0.001$; behavioral health hospitalizations, $H(3) = 935.0$, $p < 0.001$; pharmacy services, $H(3) = 550.9$, $p < 0.001$; and other non-ED services, $H(3) = 42.5$, $p < 0.001$; as well as for total non-ED service costs, $H(3) = 1093.6$, $p < 0.001$. For all non-ED services, costs increased with increasing levels of ED use. Mean values of the non-ED cost measures are reported in Table 1.

The results of the gamma regression models of the association between the total cost of non-ED service use and both patient characteristics and ED use are shown in Table 2. After adjusting for demographic and clinical characteristics, each increasing level of ED use is associated with an increase in non-ED costs. Additionally, mental illness, substance use disorders, and especially co-occurring mental illness and substance use are associated with increases in non-ED costs. Likewise, the presence of any of the selected physical conditions is associated with increases in non-ED costs. To illustrate these relationships, Figure 1 shows the predicted non-ED cost for increasing levels of ED use for each behavioral health category and by number of physical health conditions, holding all other explanatory variables at their reference level. The figure clearly shows that increasing ED use is associated with increasing non-ED costs, and it also highlights the substantially higher non-ED costs incurred by individuals with co-occurring disorders and with a greater burden of physical conditions relative to other individuals at all levels of ED use.

Subgroups of Frequent ED Users

Among frequent ED users with four or more ED visits ($n = 1,988$), the best fitting LCA model included six classes, which reflect meaningful patterns of clinical and demographic characteristics that are likely to be associated with use of non-ED services. Table 3 compares the criteria used for selecting the number of classes in the LCA model, and Table 4 shows the results of the model. We named the six classes according to the predominant characteristics of each

class: “young and healthy persons” (6%), designated as such due to their relatively younger age (60% were age 18-34) and comparatively lower rates of behavioral and physical health conditions relative to the other classes; “persons with alcohol use disorders” (15%), whose defining characteristic was their high rate of alcohol use disorders (86% had an alcohol abuse disorder either alone or in conjunction with other types of drug use and/or a mental illness); “young persons with drug use and co-occurring disorders” (18%), the majority (73%) of whom were aged 18-34 and who also had high rates of drug/alcohol use disorders and mental illness; “persons with mental illness and disability” (28%), classified as such based on their near universal designation of both disability and mental illness; “older persons with chronic illness” (10%), the overwhelming majority (84%) of whom were age 50 and above and had at least one chronic physical health condition; and “persons with trimorbid illness” (24%), identified as such because virtually all had all three of the following: a serious mental illness, a drug or alcohol use disorder, and a physical health condition. Overall, the six classes reveal substantial heterogeneity among frequent ED users in terms of demographic characteristics, rates of disability, presence of behavioral health conditions, and burden of physical conditions. Differences in race/ethnicity were particularly pronounced in some cases. For example, the majority of those in the young and healthy persons class were African American, whereas the young persons with drug use and co-occurring disorders group was predominantly white and did not include any African Americans.

The Kruskal-Wallis tests found statistically significant differences in costs among LCA classes for ambulatory care, $H(5) = 119.9, p < 0.001$; medical hospitalizations, $H(5) = 318.1, p < 0.001$; behavioral health hospitalizations, $H(5) = 113.8, p < 0.001$; pharmacy services, $H(5) = 152.2, p < 0.001$; and other non-ED services, $H(5) = 118.1, p < 0.001$; as well as for total non-ED service costs, $H(5) = 428.3, p < 0.001$. Mean non-ED costs are reported in Table 5.

Importantly, the mean cost of non-ED service use of patients in the trimorbid illness class (\$54,436) was 60% higher than that of the next costliest class, elderly persons with chronic illness (\$33,998). The mean cost of non-ED service use in the trimorbid illness class was about five times higher than the young and healthy class (\$9,794).

Discussion

Frequent ED use has been a focal point in the discussion of health care cost containment, and certain special populations, including homeless individuals, are known to use the ED with high frequency (Ku et al., 2014). A goal of simply decreasing ED use may not be sufficient to impact the unnecessary costs to both patients and the health care system. In order to develop appropriate interventions, we first need to understand the driving forces behind these ED visits. Recent attention from researchers, policymakers, and the popular media on “super-utilizers” of health care services (Bodenheimer, 2013; Chambers, Chiu, et al., 2013; Gawande; Miller, Cunningham, & Ali, 2013), coupled with growing Medicaid enrollment after expansion under the ACA, highlight the need for interventions for high-need individuals experiencing homelessness. This study reinforces the connection between frequent ED use and high health care costs among homeless individuals, and, significantly, it identifies clinical profiles of the subgroups of frequent ED users with the highest non-ED costs. Findings from this study have important implications for developing cost-effective interventions.

Our findings show that increasing levels of ED use are associated with higher costs in all categories of non-ED service use. This is particularly true among frequent ED users, who have substantially higher average costs for ambulatory care as well as for both medical and behavioral health hospitalizations than less frequent ED users. After adjusting for clinical characteristics, frequent ED use is strongly associated with increased non-ED costs. Frequent ED users were

found to have average adjusted non-ED costs that were twice as high as those who had no ED visits. This finding is consistent with prior research conducted with the more general Medicaid population, which also suggests that frequent ED users experience heavy use of non-ED health services as well (Billings & Raven, 2013). This finding is important as it suggests that homeless individuals who use the ED frequently do so as a complement to, rather than as a substitute for, other costly forms of health services such as frequent hospitalizations.

Behavioral health conditions, particularly co-occurring mental illness and substance use disorders, also surface as strong drivers of cost. Average adjusted non-ED costs for individuals with co-occurring mental illness and substance use disorders were three times higher than for individuals with no behavioral health conditions. Even for individuals with either mental illness or substance use alone, average adjusted non-ED costs were twice as high as for those with no behavioral health conditions. This finding is consistent with prior research examining costs of health care service use among persons experiencing homelessness (Flaming, Burns, & Matsunaga, 2009; Poulin, Maguire, Metraux, & Culhane, 2010).

Additionally, all of the selected physical health conditions were associated with increased costs, even after adjusting for the presence of behavioral health conditions and level of ED use. Moreover, we found that having multiple chronic physical health conditions was a strong driver non-ED costs across all levels of ED use among members of the study cohort. These findings underscore the fact that very high levels of health services utilization and costs incurred by some members of the homeless population is the result of serious, and often overlapping, health needs. We also found that the two sub-groups of frequent ED users with the highest burden of physical conditions, older persons with chronic illness and persons with trimorbid illness, were by far the costliest users of non-ED services among all those who made frequent ED use. In particular,

their inpatient medical hospitalization costs far outstripped those of persons in the other subgroups of frequent ED users. This suggests that in some cases, homeless persons who make frequent use of ED services are also severely ill, a finding that is consistent with prior studies (Chambers, Chiu, et al., 2013; Kushel et al., 2002; LaCalle & Rabin, 2010; Ruger et al., 2004).

However, homelessness may also exacerbate serious illness and lead to higher costs, thus highlighting the need for continued efforts to provide permanent housing to the most vulnerable, chronically homeless individuals, which leads to reduce utilization of acute health services among homeless persons with chronic illness (Sadowski, Kee, VanderWeele, & Buchanan, 2009).

The present study's identification of distinct subgroups of homeless frequent ED users parallels previous studies, which have identified heterogeneity among homeless individuals using latent class and cluster analyses (Aubry et al., 2012; Bonin et al., 2009; Kuhn & Culhane, 1998; Tsai, Kaspro, et al., 2013). Although differences in populations and measures used to examine heterogeneity make direct comparison difficult, our results are consistent with prior findings, which also identified relatively high-need subgroups of the homeless population with greater levels of services use. Indeed, the costliest subgroup of frequent ED users was the class of persons with trimorbid illness, whose average total non-ED cost was 60% higher than the next costliest subgroup. This subgroup had significantly higher costs in all health service categories except for ambulatory care. The second costliest subgroup, older persons with chronic illness, had high costs for medical hospitalizations and other non-ED services but notably lower costs for behavioral health hospitalizations and pharmacy services. The subgroups of persons with disability and mental illness and younger persons with drug use and co-occurring disorders both incurred high costs for behavioral health hospitalizations. Although the variation in ambulatory

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care and pharmacy costs was significant, the largest variations were seen in the costs of medical and behavioral health hospitalizations along with other non-ED services (including long term care, detoxification, crisis stabilization, and medical respite). One other finding of interest with respect to the examination of heterogeneity among subgroups of frequent users relates to the differences in racial composition between the young and healthy persons subgroup and the young persons with co-occurring disorders subgroup. Half of the young and healthy persons subgroup was African American, while more than three-quarters of the young persons with co-occurring disorders subgroup was white. This difference is worth noting and appears to be paralleled by a large difference in rates of drug and alcohol use disorders, which are much higher among the latter group. This is consistent with prior findings, which suggest that there may be racial and ethnic variations in the prevalence of substance use disorders (Mericle, Ta Park, Holck, & Arria, 2012; Nejteck et al., 2011). In sum, this study's examination of heterogeneity among homeless frequent ED users is valuable as it highlights the importance of focusing on the underlying clinical needs of frequent ED users, as opposed to solely on their patterns of healthcare utilization, when developing and implementing interventions. This conclusion is consistent with prior findings (Chambers, Chiu, et al., 2013; Kushel et al., 2002; LaCalle & Rabin, 2010), which identify factors associated with increased risk of frequent ED use, in that patients with more complex needs are likely to be ED users who merit the most attention from a cost perspective.

In this respect our findings suggest that different groups of homeless frequent ED users may benefit from interventions that vary in terms of their composition and intensity. There are several systems-design and policy implications of these findings that should guide the design of interventions. First of all, relying solely on a utilization measure like frequent ED use without

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accounting for additional factors, including the reasons for ED visits or patient characteristics, may not be enough to adequately target the highest cost patients in our health systems. Our findings highlight the need for more tailored interventions if we are to help individuals access the most appropriate level of care. Because homeless frequent ED users often have higher prevalence of medical illness, mental illness, and substance use, there is a need for a multidisciplinary, team-based approach to their care that combines primary care with behavioral health care and social services. The VA's Homeless Patient Aligned Care Team (HPACT) model has proven to be an effective approach for such team-based care, and is a promising model that could be adapted for other health care systems (O'Toole et al., 2010; O'Toole & Pape, 2015)..

Second, ED use is often felt to be a replacement for other medical services, but in many cases it is a complement to other services. This finding suggests the need for adequate outpatient engagement and follow-up in order to enhance the non-ED portions of care. It also suggests a role for non-clinical staff such as patient navigators and community health workers to assist patients in navigating to appropriate services outside of the ED.

Limitations

This study has a number of limitations that are important to note. First, the study was conducted in a single jurisdiction that has, importantly, expanded its Medicaid program, and therefore, results may not be generalizable to other settings. Second, the study population was identified based on receipt of BHCHP services, and therefore only included members of the homeless population who used such services. Thus, study findings may not be generalizable to the broader homeless population. Third, data was only available for individuals insured through Medicaid. Characteristics, patterns of service use, and costs may be different for homeless individuals with only Medicare, private insurance, or without health insurance. Fourth, the

study's observation period was limited to a single year and did not account for potential changes in utilization patterns over time. This is an especially important limitation for the analysis of heterogeneity among frequent users of ED services, as changes in ED utilization over time may be an important dimension of heterogeneity that this study was not able to capture. Similarly, it was not possible in the available data to determine the timing of ED use relative to the use of non-ED services over the course of the observation period. This made it difficult to assess the extent to which use of non-ED services may have resulted directly from an ED visit. Finally, the available data were limited in that they did not provide any information on the duration or patterns of homelessness experienced by those in the study cohort, nor did the data include any information about the receipt of housing assistance and/or other social services. Both of these factors may be associated with health services use, and so the extent to which this may have influenced the study findings remains unclear.

Conclusion

As more individuals receive access to health care through the expansion of Medicaid, it is important to understand health care utilization patterns of the most frequent health services users to appropriately target resources. This study illustrates that utilization numbers must be paired with understanding the full clinical disease burden and the social context to allow for appropriate care coordination and case management. Successful health care reform requires understanding the unique profiles of frequent user populations and developing interventions that target the complex social and clinical needs that drive their heavy service use.

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Table 1

Non-Emergency Department Costs by Levels of Emergency Department Use

Level of ED use	Ambulatory care		Medical hospitalizations		Behavioral health hospitalizations		Pharmacy		Other non-ED services		Total non-ED services	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
	0 visit	1,093	1,361	2,322	15,288	545	5,614	1,054	3,171	2,625	1,925	9,018
1 visit	1,435	1,690	4,307	17,140	945	6,673	1,325	3,282	2,724	1,887	14,639	26,437
2-3 visits	1,654	1,929	5,557	20,006	2,293	11,517	1,500	3,560	2,851	1,795	19,717	30,897
≥4 visits	1,946	2,026	11,358	28,204	6,890	15,439	2,053	4,054	2,963	1,662	36,358	43,275

Note: Dunn’s post hoc tests with Bonferroni corrections were used to make pairwise comparisons of total non-ED costs. All tests were significant at the $p < 0.001$ level. Costs are in U.S. dollars.

Table 2

Associations Between Total Non-Emergency Department Cost and Patient Characteristics

Characteristics	Model 1		Model 2		Model 3		Model 4	
	B	SE B	B	SE B	B	SE B	B	SE B
Age category								
18-34 years (ref)	-	-	-	-	-	-	-	-
35-49 years	-0.11 *	0.06	-0.27 ***	0.05	-0.23 ***	0.06	-0.19 ***	0.06
50-64 years	-0.08	0.06	-0.50 ***	0.05	-0.30 ***	0.06	-0.17 **	0.06
≥65 years	0.29 **	0.10	-0.42 ***	0.10	0.03	0.10	0.22 *	0.10
Female	-0.01	0.04	0.01	0.04	0.08	0.04	0.07	0.04
Race/ethnicity								
White (ref)	-	-	-	-	-	-	-	-
African American	-0.51 ***	0.04	-0.46 ***	0.04	-0.21 ***	0.05	-0.20 ***	0.05
Asian	-0.44 ***	0.11	-0.23 *	0.11	0.00	0.11	0.02	0.11
Hispanic/Latino	-0.39 ***	0.06	-0.41 ***	0.05	-0.26 ***	0.06	-0.19 **	0.06
Other/unreported	-0.28 **	0.09	-0.19 *	0.08	-0.07	0.09	0.02	0.09
Dual Medicare and MassHealth	0.00	0.05	-0.04	0.05	-0.06	0.05	-0.10 *	0.05
Disability	0.89 ***	0.05	0.59 ***	0.04	0.48 ***	0.05	0.48 ***	0.05
Physical conditions								
Hepatitis C			0.63 ***	0.04	0.39 ***	0.05	0.36 ***	0.05
HIV			0.37 ***	0.08	0.35 ***	0.08	0.38 ***	0.08
Cirrhosis			0.07	0.06	0.19 **	0.06	0.15 *	0.06
Hypertension			0.47 ***	0.05	0.36 ***	0.05	0.32 ***	0.05
Asthma/COPD			0.39 ***	0.04	0.31 ***	0.05	0.25 ***	0.05
Congestive heart failure			0.64 ***	0.10	0.66 ***	0.10	0.64 ***	0.10
Ischemic heart disease			0.54 ***	0.07	0.50 ***	0.07	0.48 ***	0.08
Diabetes			0.35 ***	0.05	0.40 ***	0.05	0.35 ***	0.05
Behavioral health conditions								
Mental illness only					0.69 ***	0.06	0.62 ***	0.06
Substance use only					0.65 ***	0.07	0.52 ***	0.07
Co-occurring MI and substance use					1.40 ***	0.06	1.12 ***	0.06
Emergency department utilization								
0 visits (ref)							-	-
1 visit							0.25 ***	0.06
2-3 visits							0.43 ***	0.06
≥4 visits							0.72 ***	0.06

Note: Associations were modeled using generalized linear models with a gamma distribution and log-link.

* = $p < 0.05$ ** = $p < 0.01$ *** = $p < 0.001$

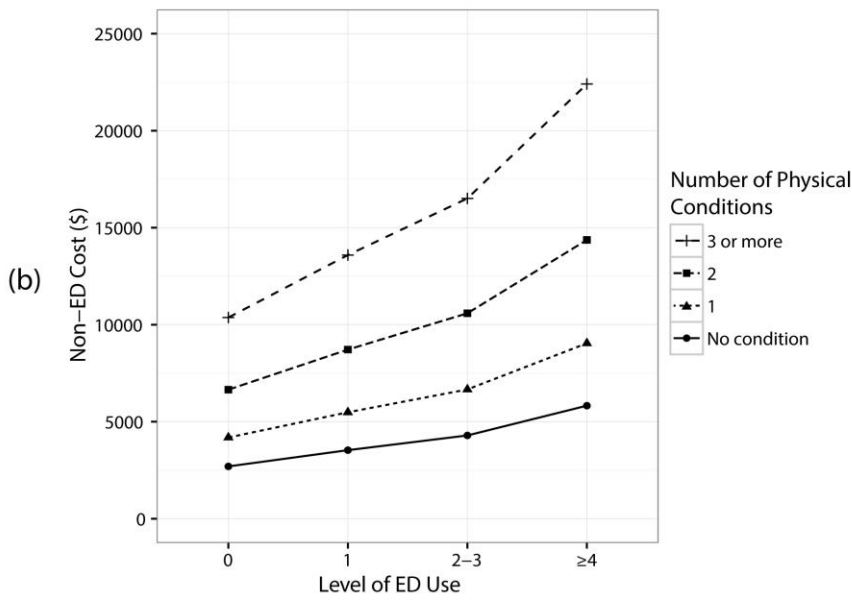
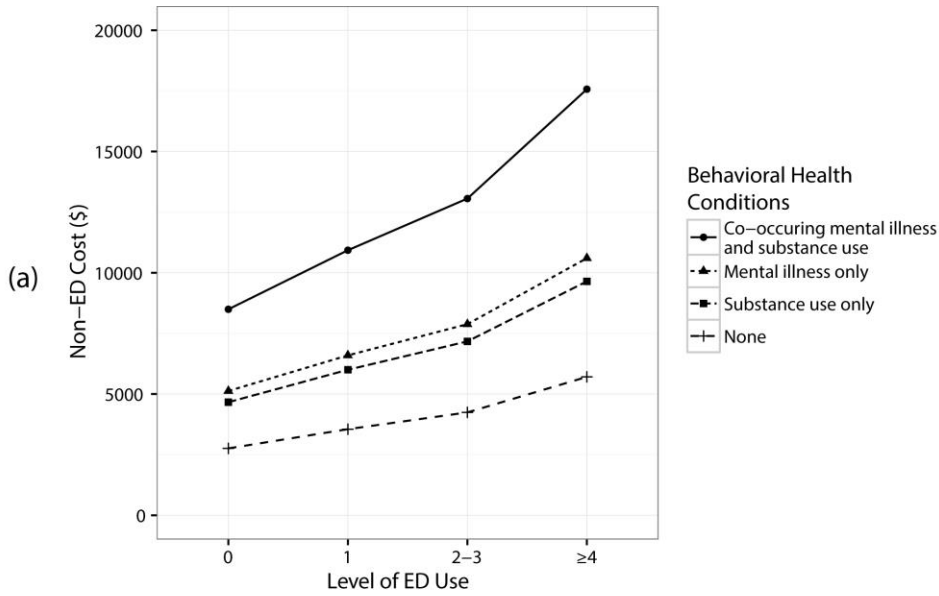


Figure 1. Predicted total non-emergency department cost in relation to level of emergency department use for Boston Health Care for the Homeless Program patients with MassHealth in 2010. Figure 1(a) displays predictions for the primary gamma regression model in the analysis, with patients grouped by behavioral health category. Figure 1(b) displays predictions for an additional gamma regression model, which groups patients by number of selected physical conditions. Increasing levels of ED use were associated with increased predicted non-ED costs. Non-ED costs varied both by behavioral health category and by number of selected physical conditions.

Table 3

Comparison of the Model Selection Criteria for Latent Class Models

Number of Latent Classes	Bayesian Information Criterion
2	36,628.70
3	36,313.57
4	36,183.10
5	36,116.90
6	36,111.15
7	36,140.47
8	36,209.48
9	36,290.65
10	36,377.58

Note: Lower Bayesian Information Criterion is preferred.

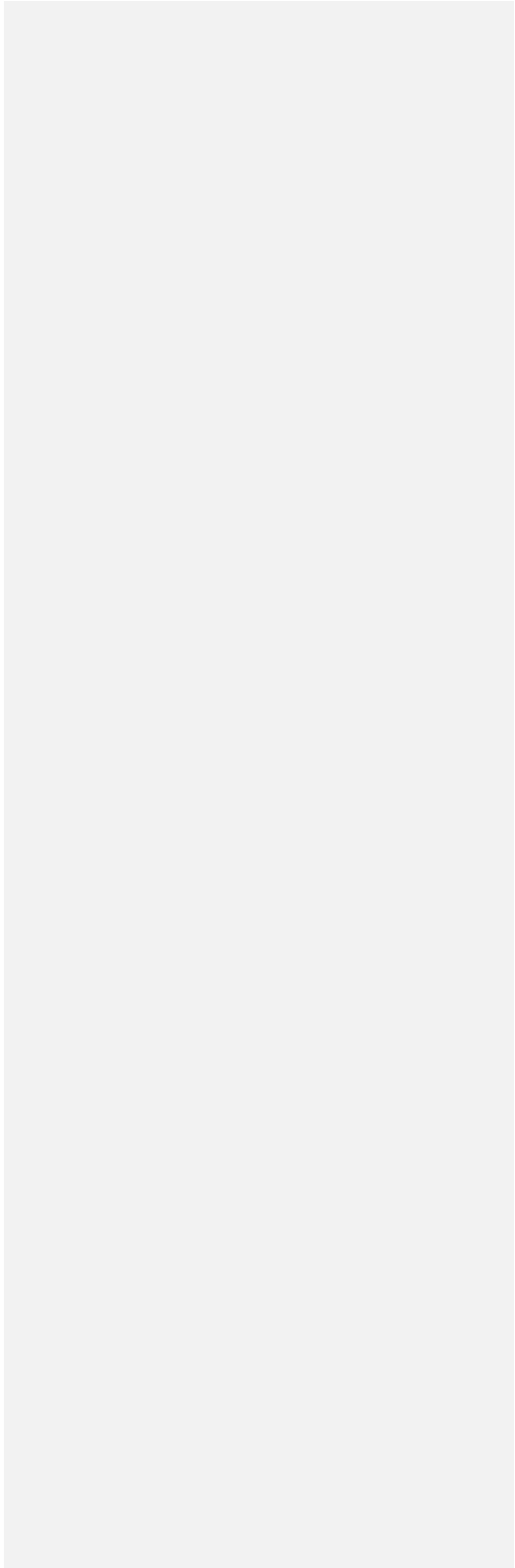


Table 4

Characteristics of Patients with Four or More Emergency Department Visits Grouped by Latent Class

Characteristics	All frequent users		Young and healthy persons		Persons with alcohol use disorders		Young persons with drug use and co-occurring disorders		Persons with mental illness and disability		Older persons with chronic illness		Persons with trimorbid illness	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Number of patients	1,988	100%	114	100%	299	100%	347	100%	564	100%	190	100%	474	100%
Age category														
18–34 years	466	23.4%	68	59.6%	2	0.7%	253	72.9%	127	22.5%	3	1.6%	13	2.7%
35–49 years	836	42.1%	40	35.1%	175	58.5%	94	27.1%	298	52.8%	27	14.2%	202	42.6%
50–64 years	638	32.1%	5	4.4%	122	40.8%	0	0.0%	139	24.6%	115	60.5%	257	54.2%
≥65 years	48	2.4%	1	0.9%	0	0.0%	0	0.0%	0	0.0%	45	23.7%	2	0.4%
Male	1,377	69.3%	42	36.8%	287	96.0%	191	55.0%	341	60.5%	128	67.4%	388	81.9%
Race/ethnicity														
African American	538	27.1%	58	50.9%	90	30.1%	0	0.0%	173	30.7%	83	43.7%	134	28.3%
Asian	40	2.0%	11	9.6%	6	2.0%	4	1.2%	11	2.0%	1	0.5%	7	1.5%
Hispanic/Latino	253	12.7%	20	17.5%	32	10.7%	53	15.3%	71	12.6%	4	2.1%	73	15.4%
Other or unreported	90	4.5%	8	7.0%	4	1.3%	22	6.3%	32	5.7%	4	2.1%	20	4.2%
White/Caucasian	1,067	53.7%	17	14.9%	167	55.9%	268	77.2%	277	49.1%	98	51.6%	240	50.6%
Disabled	1,270	63.9%	8	7.0%	92	30.8%	13	3.7%	562	99.6%	163	85.8%	432	91.1%
Dually eligible for Medicare and Medicaid	506	25.5%	0	0.0%	0	0.0%	0	0.0%	218	38.7%	142	74.7%	146	30.8%
Behavioral health disorders														
Mental illness only	207	10.4%	55	48.2%	3	1.0%	1	0.3%	74	13.1%	63	33.2%	11	2.3%
Alcohol use only	68	3.4%	0	0.0%	42	14.0%	0	0.0%	2	0.4%	16	8.4%	8	1.7%
Drug use only	43	2.2%	4	3.5%	18	6.0%	13	3.7%	0	0.0%	5	2.6%	3	0.6%
Polysubstance use only	71	3.6%	0	0.0%	32	10.7%	4	1.2%	7	1.2%	3	1.6%	25	5.3%
Mental illness and alcohol use	199	10.0%	4	3.5%	85	28.4%	0	0.0%	23	4.1%	64	33.7%	23	4.9%
Mental illness and drug use	315	15.8%	7	6.1%	6	2.0%	127	36.6%	109	19.3%	2	1.1%	64	13.5%
Mental illness and polysubstance use	1,014	51.0%	12	10.5%	98	32.8%	202	58.2%	339	60.1%	23	12.1%	340	71.7%
Selected physical conditions														
Hepatitis C	697	35.1%	0	0.0%	33	11.0%	182	52.4%	176	31.2%	0	0.0%	306	64.6%
HIV	150	7.5%	0	0.0%	3	1.0%	8	2.3%	57	10.1%	1	0.5%	81	17.1%
Cirrhosis	324	16.3%	5	4.4%	49	16.4%	11	3.2%	0	0.0%	49	25.8%	210	44.3%
Hypertension	872	43.9%	9	7.9%	111	37.1%	50	14.4%	85	15.1%	161	84.7%	456	96.2%
Asthma/COPD	762	38.3%	34	29.8%	47	15.7%	109	31.4%	227	40.2%	79	41.6%	266	56.1%
Congestive heart failure	120	6.0%	1	0.9%	1	0.3%	4	1.2%	6	1.1%	23	12.1%	85	17.9%
Ischemic heart disease	251	12.6%	1	0.9%	9	3.0%	7	2.0%	23	4.1%	46	24.2%	165	34.8%
Diabetes	434	21.8%	16	14.0%	33	11.0%	19	5.5%	63	11.2%	90	47.4%	213	44.9%

Table 5

Mean Non-Emergency Department Costs Among Patients with Four or More Emergency Department Visits Grouped by Latent Class.

Latent class	Ambulatory care		Medical hospitalizations		Behavioral health hospitalizations		Pharmacy		Other non-ED services		Total non-ED services	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
	Young and healthy persons	1,353	1,369	2,518	8,070	2,022	9,952	612	975	3,289	3,692	9,794
Person with alcohol use	1,501	1,631	3,939	9,385	2,787	7,155	1,217	2,744	5,890	10,590	15,334	19,454
Young persons with drug and co-occurring disorders	1,507	1,607	4,118	9,666	6,229	15,392	2,016	2,388	3,481	3,448	17,351	20,033
Persons with disability and mental illness	1,835	1,844	6,345	14,625	7,780	16,265	2,024	3,810	4,975	7,262	22,959	25,603
Older persons with chronic illness	2,628	2,702	16,866	35,722	5,163	15,353	947	1,874	8,395	11,771	33,998	40,918
Persons with trimorbid illness	2,548	2,313	27,223	45,291	10,766	18,144	3,433	6,153	10,466	14,956	54,436	53,734

Note: Dunn's post hoc tests with Bonferroni corrections were used to make pairwise comparisons of total non-ED costs. All tests were significant at the $p < 0.001$ level, except for young persons with drug and co-occurring disorders compared to persons with disability and mental illness and for young persons with drug and co-occurring disorders compared to older persons with chronic illness. Costs are in U.S. dollars.