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Research Article

Hospitalization Trajectories in Home- and Community-Based Services Recipients: The Influence of Physician and Social Care Density

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Abstract

Objectives: Repeated hospitalizations among older adults receiving Home- and Community-Based Services (HCBS) may indicate unmet medical and social needs. This study examined all-cause hospitalization trajectories and the association between area-level resource density for medical and social care and the trajectory group membership.

Methods: The study participants included 11,223 adults aged 60 years or older who were enrolled in public HCBS programs in Michigan between 2008 and 2012. Data sources included the Michigan interRAI-Home Care, Dartmouth Atlas of Health Care Data, the American Community Survey, and the County Business Patterns from the Census Bureau. The group-based trajectory modeling was used to identify trajectories of hospitalization over 15 months. Correlates of the trajectories were examined using multinomial logistic regression.

Results: Four distinct hospitalization trajectory groups emerged: "never" (43.1%)—individuals who were rarely hospitalized during the study period, "increasing" (19.9%)—individuals who experienced an increased risk of hospitalization, "decreasing" (21.6%)—individuals with a decreased risk, and "frequent" (15.8%)—individuals with frequent hospitalizations. Older adults living in areas with a higher number of social service organizations for older adults and persons with disability were less likely to be on the "frequent" trajectory relative to the "decreasing" trajectory. The density of primary care physicians was not associated with the trajectory group membership.

Discussion: Area-level social care resource density contributes to changes in 15-month hospitalization risks among older adult recipients of HCBS.

Keywords: Home- and Community-Based Services, Hospitalization trajectory, interRAI-HC, Primary care physician density, Social care density

Home- and Community-Based Services (HCBS) are a growing segment of the United States' health care system due to a shift from institutional long-term care to community-based care. In 2017, about 4.6 million individuals received Medicaid HCBS with joint federal and state spending totaling $82.7 billion (Musumeci et al., 2019), surpassing the Medicaid spending on institutional care (Wenzlow et al., 2016). Despite the growing share of HCBS spending, older adult recipients of HCBS remain an understudied population, and their health care utilization patterns are rarely examined. HCBS recipients often face complexities in medical care due to multimorbidity and overlapping disabilities (Lehnert et al., 2011; Walsh et al., 2012). Although community living generally promotes better psychological

well-being, HCBS recipients may have a higher risk for adverse health events such as hospitalization compared to their institutional care counterparts, who receive more rigorous symptom monitoring (Konetzka, 2014; Wilson & Truman, 2005; Wysocki, Kane, Golberstein, et al., 2014). Frequent hospitalizations increase health care costs to the taxpayer and the individual patient and are a precursor to functional decline, institutionalization, and death (Boyd et al., 2008). Reducing hospitalizations, therefore, has important implications for the health and well-being of HCBS recipients and health care policies.

Patterns of hospital admission and readmissions and associated risk factors have been extensively studied in the general adult population and disease-focused subpopulations (Chaudhry et al., 2013; García-Pérez et al., 2011). However, only a few studies have focused on HCBS recipients, who tend to have more complex medical and social needs (Walsh et al., 2012; Wysocki, Kane, Golberstein, et al., 2014). Most of these studies compared hospitalization rates between HCBS recipients and residents of institutional long-term care among Medicare–Medicaid dual eligibles (Walsh et al., 2012; Wysocki, Kane, Golberstein, et al., 2014). A related body of literature examined risk factors for hospital readmissions up to 90 days from the start of home health services among Medicare home health patients (Chase et al., 2020; Fortinsky et al., 2014; Lohman et al., 2018; Wolff et al., 2008). They found that hospitalized adults tended to be older and were more likely to be Black than White (Chase et al., 2020; Fortinsky et al., 2014; Wolff et al., 2008), live alone (Chase et al., 2020; Fortinsky et al., 2014), and have more functional impairments, chronic illnesses, and clinical complications (Fortinsky et al., 2014; Lohman et al., 2018). These studies have examined no more than two time points to estimate the hazard of and time until hospitalization or rehospitalization. However, hospitalization patterns among HCBS recipients can be complicated, and an extended period may better capture this complexity. Methods that allow the identification of subgroups following distinctive hospitalization trajectories over time can inform targeted interventions and strategies for those at the most risk for repeated hospitalizations.

Another knowledge gap is the limited understanding of risk factors for repeated hospitalizations beyond patient characteristics. Previous studies focused on HCBS recipients contributed to our knowledge by identifying several individual-level risk factors, such as multimorbid conditions (Fortinsky et al., 2014), informal caregiver stress (Shugarman et al., 2002), and fewer hours of formal care (Xu et al., 2010). Previous studies focusing on the individual-level factors placed an implicit assumption that variation in medical and social care resources across areas is small. However, repeated hospitalizations among HCBS recipients may be an indicator of unmet care needs in the community. For instance, social services in the community, such as transportation, enable the patient to seek timely outpatient care, reducing subsequent hospital admissions. Area-level formal care resources may influence hospitalization risks among HCBS participants in three different ways. First, the geographic distribution of primary health care resources influences HCBS recipients' availability to receive preventive and post-acute care in outpatient settings and reduce hospitalization. Although not yet examined in the HCBS population, existing literature has extensively documented the geographic variation in primary health care access and its impact on health care utilization and outcomes in the general adult population (Rosano et al., 2012), with fewer primary care physicians (PCPs) per capita associated with an increased rate of potentially preventable hospitalization (Lin et al., 2016; Ricketts et al., 2001). Second, a high density of health-promoting resources in the neighborhood (e.g., senior center) may increase HCBS participants' social engagement (Levasseur et al., 2011), which, in turn, reduces hospitalization in vulnerable older adults (Newall et al., 2015). Living in neighborhoods with gym/recreational centers lower the preventable hospitalization rates among African Americans (Bell et al., 2017). Third, community social care resources may reduce hospitalizations among HCBS older adults through increased self-care management skills among patients and families who care for them. Geriatric and chronic care models (Counsell et al., 2006; Epping-Jordan et al., 2004) define community resources as entities providing complementary services to primary health care systems (e.g., health education, care coordination) and document lowering rates of hospital readmission once patients receive quality community-based services (Parker et al., 2014). However, such patient-focused studies limit the inference of how area-level differences in resources contribute to hospitalization experiences.

The present study aimed to identify 15-month hospitalization trajectories among older adult recipients of HCBS and examine the impact of living in an area with varying density of formal health care resources. We focused on the density of PCPs and social service organizations for older adults and persons with disabilities. PCP capacity has been a widely used indicator to address community-level medical needs (e.g., medically underserved areas designation). We paid attention to social service organizations instead of individual providers (e.g., social workers, nurses). Most social service providers provide services through an organization. The information on service organizations is readily available and complete (e.g., as they must be registered with state authorities). In contrast, information on individual providers is harder to collect and less complete (e.g., due to limited licensure requirements).

Method

Data and Participants

Several data sources were merged to create a data set that contained both individual-level characteristics and area-level resource variables. Individual HCBS recipient data

came from the Michigan interRAI-Home Care (RAI-HC) Assessment 2008–2014, a comprehensive clinical assessment tool to monitor and develop care plans for HCBS recipients. Like most states, Michigan offers HCBS to eligible persons through various federal- and state-funded programs, including the Medicaid 1915(c) HCBS waivers, the Money Follows the Person demonstration program, and aging services based on amendments to the 1965 Older Americans Act. Typically, care management teams of nurses and social workers from the local agencies use uniform assessment tools in the RAI-HC to conduct comprehensive client assessments at intake and follow-up assessments every 90 days. Assessors collect data on multiple domains, including cognition, functional status, disease diagnoses, medication, and service use (Morris et al., 2010). They ascertain valid responses from multiple sources of information, including the client's and caregiver's responses to the items on the assessment forms, direct observation, and review of medical records or physician's notes, if available (Morris et al., 2010). Participants entered into the Michigan RAI-HC 2008–2014 database at different times, and thus, the 2008 cohort includes both newly enrolled individuals and those who participated before 2008. We focused on assessment over a first 15-month period, corresponding to an average of 5 assessment visits for each individual (M = 4.99, SD = 1.32).

A total of 16,596 persons were enrolled in the HCBS program between 2008–2012, aged ≥ 60 years, resided in metropolitan areas, and had a valid Michigan ZIP Code. We focused on metropolitan areas considering that rural areas have different financial, legal, and regulatory incentives for hospitalization. The vast urban–rural differences in health care access may mask the differences within urban communities (Hart et al., 2005). We excluded individuals who (a) had only one assessment in the data set (N = 3,642), (b) lived in a nursing home or inpatient rehabilitation facility during the entire study period (N = 630), (c) had missing values on their residential status (N = 74), (d) changed their ZIP Code during the study period (N = 922), and (e) had missing data on hospitalization status across all assessment points (N = 75). The remaining 11,223 individuals contributed 50,380 assessment points over 15 months. During the study period, one third of the study sample (N = 3,734 participants or 33.2%) dropped out due to death, institutionalization, or ending enrollment in the HCBS program.

The Dartmouth Atlas of Health Care, a data repository from the Dartmouth Institute, provided health care resource measures by Hospital Service Area (HSA) for available years (2006, 2011, 2012). The 2008–2012 County Business Patterns (CBP) provided annual subnational economic data by industry and aggregated at the ZIP Code. Additional contextual data came from the 2008–2012 American Community Survey (ACS) 5-year estimates. We transformed ZIP Codes to ZIP Code Tabulation Areas (ZCTAs) using a crosswalk (John Snow Inc., 2015) to merge the CBP and the ACS. Both HSA-level and ZCTA-level data are then merged with HCBS recipient data using each participant's ZIP Code in the RAI-HC. Study participants were clustered in 478 ZCTAs, which were nested in 66 HSAs.

Measures

Hospitalization

The RAI-HC provides information on whether respondents had any acute inpatient admission (i.e., the receipt of active treatments in inpatient-hospital settings for medical necessity) with an overnight stay in the past 90 days or since the last assessment if the previous assessment occurred within 90 days. We used a dichotomous indicator of hospitalization for each assessment in trajectory modeling.

Independent variables

We used Andersen's Behavioral Model of Health Services Use (Andersen, 2008; Andersen et al., 2011) to conceptualize and select predictors. Andersen's model classifies determinants of health service use into three categories: *predisposing factors,* including demographic (e.g., age and gender) and socio-structural (e.g., race/ethnicity) measures; *enabling factors*, including resources that provide individuals with the means to obtain and make use of services (e.g., income, health insurance, access to transportation, social resources); and *need factors*, including both perceived and evaluated needs of hospital use (i.e., diagnosed with health conditions). This model also conceptualizes resources that facilitate access to disease prevention and management services as community-level enabling factors.

Predisposing factors

Demographic characteristics included age, sex, and race/ethnicity.

Need factors

Need factors included a dichotomous indicator of any clinical complications (vomiting, fever, deterioration, weight loss, surgical wounds, chest pain, flare-up, fluid retention, diarrhea, and shortness of breath), a dichotomous indicator of any ambulatory care-sensitive conditions (urinary tract infection, pneumonia, congestive heart failure, chronic obstructive pulmonary disease, coronary disease, hip fracture, and other fractures) (Intrator et al., 2004), and the tally of 14 physician-diagnosed chronic conditions (cancer, diabetes, anxiety, bipolar disorder, depression, schizophrenia, stroke, Parkinson's disease, paraplegia, quadriplegia, multiple sclerosis, hemiplegia, Alzheimer's disease, and other dementia). Need factors also included limitations in activities of daily living (ADL) based on the interRAI ADL scale (0–28), which assessed the level of dependence performing seven tasks (bed mobility, mobility/transfer, locomotion, dressing, eating, toilet use, and personal hygiene) (Cronbach's α = 0.93; Morris et al., 1999). Limitations

in instrument activities of daily living (IADL) as assessed by the interRAI IADL involvement scale (0–48) summed difficulties in seven domains, including meal preparation, ordinary housework, managing finances, managing medications, phone use, shopping, and transportation (Cronbach's α = 0.81; Morris et al., 1999). The assessment of depressive symptoms involved the depression rating scale (0–14) (Cronbach's α = 0.69; Burrows et al., 2000). Lastly, cognitive function was measured using the Cognitive Performance Scale (CPS) (0–6) based on four items in the interRAI assessment system and captured loss in everyday cognitive performance (Cronbach's α = 0.71; Morris et al., 1994). A lower cognitive score indicates cognitively intact, and a higher score indicates full dependence (e.g., unable to make decisions or recall what just occurred) (Morris et al., 2016).

Enabling factors

Enabling factors included a dichotomous indicator of living alone, a three-category indicator of social isolation, and program types at baseline. Social isolation measure was created based on two questions: (a) whether the respondent had a decline in the level of participation in social, religious, occupational, or other preferred activities, as compared to 90 days ago or since the last assessment if less than 90 days ago, and (b) whether they were distressed about the decline. It was coded as 0 if a recipient had no decline in the level of participation, coded 1 if the client had a decline in participation but was not distressed, and 2 if the participant had a decline and was distressed. To reflect the potential difference in medical and social needs among participants depending on the type of HCBS programs (Weaver & Roberto, 2018; Wysocki, Kane, Dowd, et al., 2014), we controlled the program types consisted of four categories at baseline: (a) Medicaid Waiver eligible, including Medicaid 1915(c) HCBS waivers, (b) Medicaid Waiver ineligible, financially ineligible, or denied, (c) participants of the Office of Services to the Aging (OSA) Programs, and (d) participants of the Nursing Facility Transition Program (NFTP), funded by the Medicaid Money Follows the Person Rebalancing Demonstration Grant from 2008 and after. To account for the secular trend of hospitalization rates, we included enrollment year.

Community-level enabling factors

The density of PCPs and social services providers were two key variables of interest. The density of PCPs, defined as the number of PCPs per 100,000 residents in HSAs, was available in the Dartmouth Atlas of Health Care for 2006 and 2011. Linear interpolation was used to obtain the between-year values, which are then matched to participants' baseline year, with the 2012 value drawn from 2011. The density of social service providers referred to the total number of social service organizations for older adults (officially labeled as "the elderly" in the North American Industry Classification System (NAICS)) and persons with disabilities at each ZCTA, categorized as code 624120 in the 6-digit NAICS (NAICS) from the annual County Business Patterns database. Examples of code 624120 organizations include senior centers, adult day-care, and nonmedical home care programs.

We included a few area-level confounders, including hospital capacity (the number of acute hospital beds per 100,000 residents in each HSA and measured through a linear interpolation of 2006 and 2012 data from Dartmouth Atlas), age structure (percent of individuals 65 years and older), logged number of residents per square mile to account for commercial versus residential zoning type, and logged area size in square miles. These variables came from the ACS and were captured at the ZCTA-level.

Statistical Analysis

We conducted univariate analyses for sample description. To identify hospitalization trajectories during a 15-month study period, we applied the enhanced group-based trajectory modeling adjusting for nonrandom attrition (Haviland et al., 2011). We used a dichotomous indicator of hospitalization in each assessment for all assessment points for each participant. Subsequently, we examined the baseline correlates associates with the trajectory groups identified in the first phase, using multinomial logistic regression.

Group-based trajectory modeling is a specialized application of finite mixture modeling techniques that identify clusters of individuals who follow similar progressions of the outcome (Nagin & Nagin, 2005). The basic model assumes independence of probabilities of group membership and attrition, leading to biased trajectory group membership especially when the outcome of interest is associated with attrition. We modeled hospitalization risk as a finite set of different polynomial functions of time, measured as months since the first assessment. Attrition was modeled as a constant rate within each group using a logit distribution. Probabilities of dropout and group membership were assumed to be dependent in the enhanced model, and hospitalization trajectory shapes and probabilities of dropout were estimated simultaneously. The best model was selected using the Bayesian Information Criteria (BIC), average posterior probability, and the log Bayes factor to compare models (see Supplementary Document for details).

Subsequently, multivariable multinomial logistic regression models were estimated to identify baseline factors associated with the assigned group membership. Some covariates had missing values between 0% and 10% of the data. We assumed data were missing at random and imputed missing values using chained equations models (White et al., 2011). Clustering at each level was 19.3 individuals per ZIP Code (Min = 1, Max = 292) and 170 individuals per HSA (Min = 1; Max = 1,614). Less than 2.5% of the variation in hospital trajectory

memberships was attributable to clustering at HSA or ZCTA-within-HSA. We clustered standard errors by HSA to account for the residual correlations within the geographic area and minimize Type I error. A series of models were fitted using the *Traj* plug-in and *mlogit* in STATA 15.0 (StataCorp, 2017).

Results

Study Population Characteristics

Table 1 describes the study sample characteristics based on imputed data. The average age of the participants was 77 years old. The majority were female (73.2%), non-Hispanic White (64.7%), had a clinical complication (62.6%), had an acute condition (59.%), and had an average of two chronic conditions at the baseline. Less than 40% lived alone. More than half of HCBS users were participants of Medicaid Waivers, whereas 5.7% were ineligible for Medicaid Waivers at baseline, a quarter was in OSA and other federal programs, and 1 in 10 were in NFTPs at baseline. Participants, on average, had 77.1 PCPs per 100,000 residents in their HSAs, and 1.8 social service organizations for older adults and persons with disabilities in their ZCTAs. A comparison of baseline characteristics by group membership, before and after imputation, is available in the Supplementary Tables 1 and 2.

Model Selection for Group Membership

A logit model with four trajectory groups was the best solution for our data. As shown in Figure 1, Panel A, Group 1 ("never") largely remained nonhospitalized, representing 43.1% of the sample. Group 2 ("increased"), representing 19.9% of the sample, has a low risk of hospitalization initially, but this risk grew moderately over time. Group 3 ("decreased"), representing 21.6% of the sample, captured participants who were initially hospitalized but largely remained nonhospitalized over time. Group 4 ("frequent") showed consistently moderate to high levels of hospitalization risk and represented 15.8% of the sample. The probabilities of attrition did not differ substantially across trajectory groups (Supplementary Figure 1).

Baseline Factors Associated With Hospitalization Trajectories

Tables 2 and 3 present the results of multinomial logistic regressions that identify risk factors associated with the hospitalization trajectory groups. We first used the "never" trajectory as a reference group and further used "decreased" as a reference group to compare risk profiles between the "decreased" and the "frequent" groups.

Results from the multinomial logistic regression using "never" as the reference category showed that area-level resource characteristics did not differentiate the hospitalization trajectories (Table 2). However, residing in ZIP Codes with more social service organizations for the older adults and persons with disabilities differentiated the "frequent" group from the "decreased" group. HCBS users with more social service organizations nearby had a lower

Table 1. Baseline Characteristics in Michigan HCBS Sample (2008–2012), After Imputation

Characteristics	Mean/frequency (95% confidence interval)
Area-level characteristics	
PCP density	77.05 (76.78, 77.33)
Hospital capacity	2.28 (2.26, 2.29)
Social service density	1.77 (1.73, 1.80)
Percent 65+	13.65 (13.59, 13.71)
Land size (logged)	3.01 (2.99, 3.03)
Population density (logged)	7.01 (6.99, 7.04)
Individual-level characteristics	
Age groups (mean)	77.03 (76.84, 77.22)
Sex (%)	
Female	73.16 (72.32, 74.00)
Race/ethnicity (%)	
Non-Hispanic White (reference)	64.73 (63.83, 65.64)
Non-Hispanic Black	29.09 (28.23, 29.95)
Hispanic and additional groups	6.18 (5.72, 6.64)
Any clinical complications (%)	62.61 (61.69, 63.53)
Any acute conditions (%)	58.99 (58.06, 59.92)
Chronic disease count (mean)	2.08 (2.05, 2.10)
ADL limitations (0–28) (mean)	7.61 (7.46, 7.76)
IADL limitations (0–48) (mean)	34.84 (34.64, 35.04)
Cognitive function (0–7) (mean)	1.75 (1.72, 1.78)
Depressive symptoms (0–14) (mean)	1.11 (1.07, 1.14)
Live alone (%)	38.75 (37.83, 39.68)
Social isolation (%)	
No decline	76.28 (75.48, 77.09)
Decline, not being depressed	16.11 (15.41, 16.81)
Decline, being depressed	7.61 (7.10, 8.11)
Initial program status (%)	
Medicaid Waivers	57.11 (56.19, 58.02)
Medicaid ineligible	5.75 (5.32, 6.18)
OSA	25.86 (25.05, 26.67)
Nursing Facility Transition	11.29 (10.70, 11.87)
Enrollment year	
2008	39.13 (38.23, 40.04)
2009	24.00 (23.21, 24.79)
2010	12.93 (12.31, 13.55)
2011	11.71 (11.11, 12.30)
2012	12.23 (11.63, 12.84)

Notes: *N* = 11,223. ADL = activities of daily living; HCBS = Home- and Community-Based Services; IADL = instrumental activities of daily living; OSA = Office of Services to the Aging; PCP = primary care physician. PCP density measures the number of PCPs per 100,000 residents in the Hospital Service Area (HSA). Hospital capacity measures the number of acute hospital beds per 100,000 residents in each HSA. Social service density measures the total number of social service organizations for the older adults and persons with disabilities at each Zip Code Tabulation Area.

expected risk of being on the "frequent" trajectory, compared to the "decreased" trajectory (p = .028) (Table 3).

Results from models using "never" as the reference category showed several common risk factors that distinguished the two hospitalized groups at the initial phase of the 15 months ("decreased" and "frequent") from the hospitalization-free group ("never" trajectory). They include having any clinical complications, having any acute conditions, a decline in social activities and being distressed about it, and being participants in the NFTPs. A few factors uniquely distinguished the "increased" group from the "never" group, such that the relative risk of being in the "increased" group was higher among those with any clinical or acute conditions but lower among OSA participants. High cognitive impairment lowered the relative risk of three hospitalization groups compared to the hospitalization-free group (Table 2).

The multinomial logistic regression using "decreased" as the reference category showed that having an acute condition increased the expected risk of being on the "frequent" trajectory. The expected risk of being on the "frequent" versus "decreased" trajectory decreased with a high level of cognitive impairments, having a decline in social activities (without accompanied distress), participating in NFTP compared to Medicaid Waivers (Table 3).

Sensitivity Analysis

Previous studies have shown that methods using the missing at random assumption can lead to biased estimates of trajectory group size under certain conditions (Haviland et al., 2011; Zimmer et al., 2012). As compared to findings from the joint model accounting for attrition, models not accounting for attrition did not over- or underrepresented the trajectory group assigned. Specifically, the basic model not accounting for unequal attrition assigned 42.4%, 20.1%, 21.7%, and 15.8% of the sample to the "never," "increased," "decreased," and "frequent" trajectories, respectively. The similarities in the estimates of group size may be due to the small differences in attrition rates across the trajectory groups (Supplementary Figure 1).

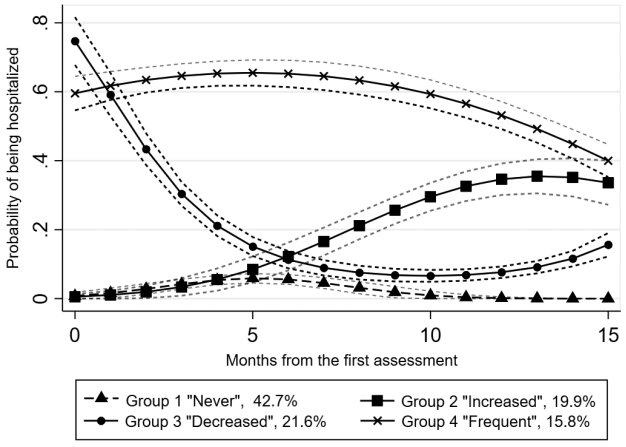

Figure 1. Trajectories of hospitalization over 15 months jointly modeled with attrition. *Note*: The trajectories of hospitalization with the estimated probability of being hospitalized at each month study for each trajectory group. The estimated proportion in groups (%). The gray dash lines around the trajectory line represent 95% confidence intervals.

Discussion

The present study expanded research on the HCBS population by examining hospitalization trajectories over 15 months and considering area-level primary care and social service density that shapes these trajectories. Four distinct hospital utilization trajectories emerged in an enumerative sample of the metropolitan Michigan area receiving HCBS. A significant number (15%) had a persistent risk of hospitalization over the 15 months. One-fifth had a higher risk of hospitalization at the start, followed by a reduction in those risks. The present study found that living in dense social care resource areas distinguished groups with different hospitalization patterns over time. PCP density was not associated with the trajectory groups. Addressing geographic differences of formal health care resources may be one way to reduce the individual, social, and economic burden of frequent hospitalizations of the HCBS population.

We found living in an area with a high density of social services lowered the risk of being subsequently and repeatedly hospitalized among those who had an increased risk of hospitalization at the beginning of the 15 months. Our study reveals that service density may be more critical for HCBS participants who are already hospitalized and requiring further medical and social supports in the community. A high number of social service organizations may have provided HCBS participants and their families better material, social, and educational resources during the post-hospital care period. An increasing number of studies highlight the crucial roles that non-health care organizations reduce readmissions through health and social care partnerships (e.g., Brewster et al., 2018). Although health and social care partnerships are still possible in communities with a low density of social service providers, more social service providers in the area improve the likelihood of such partnerships. Future research that directly incorporates measures of the coordination level among health and social care providers will enhance our understanding of the role social service organizations play in shaping hospitalization trajectory outcomes.

We did not find evidence that the local supply of PCP shaped the hospitalization trajectory. This finding is inconsistent with previous studies that suggested local physician capacity as a critical factor for reducing the need for hospitalization, possibly through increased opportunities for disease prevention and wellness management in outpatient care (Daly et al., 2018; Lin et al., 2016). Inconsistent findings may reflect a difference in the study population. Older adults receiving HCBS may

Table 2. Multinomial Logistic Regression Model: Relative Risk Ratios for Hospitalization Group Membership Using the "Never" Group as Reference

	Increased vs never	Decreased vs never	Frequent vs never
	Coefficient (95% confidence interval)	Coefficient (95% confidence interval)	Coefficient (95% confidence interval)
Area-level characteristics			
PCP density	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)	1.00 (0.99, 1.00)
Hospital capacity	1.05 (0.93, 1.18)	1.11 (0.95, 1.29)	1.15 (0.92, 1.44)
Social service density	1.00 (0.97, 1.04)	1.02 (0.98, 1.07)	0.97 (0.93, 1.01)
Percent 65+	1.00 (0.98, 1.02)	1.00 (0.98, 1.01)	0.99 (0.97, 1.02)
Land size (logged)	0.91 (0.81, 1.02)	0.93 (0.86, 1.01)	1.04 (0.92, 1.17)
Population density (logged)	0.93* (0.87, 1.00)	0.91* (0.84, 0.98)	1.08 (0.98, 1.18)
Individual-level characteristics			
Age	1.03 (0.95, 1.12)	1.20** (1.08, 1.33)	1.11* (1.02, 1.21)
Age-squared	1.00 (1.00, 1.00)	1.00*** (1.00, 1.00)	1.00** (1.00, 1.00)
Female	1.14 (0.99, 1.31)	0.98 (0.87, 1.10)	0.87* (0.78, 0.98)
Race/ethnicity			
NH White	Reference	Reference	Reference
NH Black	1.08 (0.92, 1.27)	1.09 (0.88, 1.35)	1.10 (0.90, 1.35)
Hispanic and additional groups	1.05 (0.81, 1.37)	1.03 (0.83, 1.29)	1.05 (0.79, 1.38)
Any clinical complications	1.11* (1.00, 1.23)	2.33*** (1.99, 2.72)	2.32*** (1.96, 2.74)
Any acute conditions	1.51*** (1.36, 1.67)	1.75*** (1.49, 2.06)	2.16*** (1.78, 2.60)
Chronic disease count	1.02 (0.97, 1.07)	1.03 (0.99, 1.07)	1.07** (1.03, 1.12)
ADL limitations (0–28)	1.00 (0.99, 1.01)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)
IADL limitations (0–48)	1.00 (0.99, 1.01)	1.01 (1.00, 1.02)	1.01** (1.00, 1.02)
Cognitive function (0–7)	0.93** (0.89, 0.97)	0.93** (0.88, 0.97)	0.85*** (0.82, 0.89)
Depressive symptoms (0–14)	1.00 (0.96, 1.05)	1.00 (0.97, 1.03)	1.02 (0.98, 1.06)
Live alone	0.90 (0.81, 1.01)	1.09 (0.92, 1.28)	1.07 (0.90, 1.26)
Social isolation			
No decline	Reference	Reference	Reference
Decline, not being depressed	1.03 (0.89, 1.19)	1.83*** (1.50, 2.23)	1.46*** (1.30, 1.63)
Decline, being depressed	1.14 (0.89, 1.46)	2.35*** (2.03, 2.72)	2.07*** (1.74, 2.46)
Initial program status			
Medicaid Waivers	Reference	Reference	Reference
Medicaid ineligible	0.79 (0.53, 1.19)	1.14 (0.88, 1.47)	0.87 (0.70, 1.09)
OSA	0.79** (0.68, 0.90)	1.09 (0.86, 1.37)	0.93 (0.78, 1.10)
Nursing Facility Transition	0.95 (0.73, 1.22)	3.84*** (3.20, 4.60)	2.34*** (1.84, 2.98)
Enrollment year			
2008	Reference	Reference	Reference
2009	1.01 (0.87, 1.18)	1.49*** (1.20, 1.85)	1.18 (0.99, 1.40)
2010	1.08 (0.89, 1.30)	1.70*** (1.36, 2.12)	1.00 (0.79, 1.26)
2011	1.07 (0.87, 1.31)	1.84*** (1.50, 2.26)	1.12 (0.89, 1.39)
2012	1.08 (0.82, 1.42)	1.70*** (1.33, 2.17)	1.16 (0.90, 1.50)

Notes: ADL = activities of daily living; IADL = instrumental activities of daily living; NH = non-Hispanic; OSA = Office of Services to the Aging; PCP = primary care physician.
***$p < .001$. **$p < .01$. *$p < .05$.

have greater access to PCPs than the general adult population. Moreover, indicators of primary care quality were unavailable. Future studies that consider geographic disparities in care quality can better clarify primary care's impact on hospitalization trajectories.

Aside from area-level resources, a few patient characteristics and program status emerged as important factors that differentiated subgroups. In line with previous studies, we found older adults with clinical complications and acute, chronic, and medical conditions had a consistently higher risk of repeated hospitalization (Lohman et al., 2018; Muenchberger & Kendall, 2010; Wolff et al., 2008). While previous research reported unmet care needs in homes among black HCBS recipients (Cai & Temkin-Greener, 2015), we did not find an increased risk of repeated

Table 3. Multinomial Logistic Regression Model: Relative Risk Ratios for Hospitalization Group Membership Using the "Decreased" Group as Reference

	Increased vs decreased	Frequent vs decreased
	Coefficient (95% confidence interval)	Coefficient (95% confidence interval)
Area-level characteristics		
PCP density	1.00 (1.00, 1.01)	1.00 (0.99, 1.01)
Hospital capacity	0.95 (0.83, 1.08)	1.04 (0.88, 1.22)
Social service density	0.98 (0.93, 1.03)	0.95* (0.90, 0.99)
Percent 65+	1.00 (0.98, 1.03)	1.00 (0.98, 1.02)
Land size (logged)	0.98 (0.87, 1.10)	1.12+ (1.00, 1.25)
Population density (logged)	1.02 (0.94, 1.11)	1.19*** (1.08, 1.31)
Individual-level Characteristics		
Age	0.86* (0.77, 0.97)	0.93 (0.81, 1.06)
Age-squared	1.00* (1.00, 1.00)	1.00 (1.00, 1.00)
Female	1.17 (0.99, 1.37)	0.89 (0.78, 1.02)
Race/ethnicity		
NH White	Reference	Reference
NH Black	0.99 (0.82, 1.20)	1.01 (0.83, 1.23)
Hispanic and additional groups	1.02 (0.76, 1.36)	1.01 (0.77, 1.32)
Any clinical complications	0.48*** (0.39, 0.58)	0.99 (0.83, 1.19)
Any acute conditions	0.86 (0.72, 1.03)	1.23* (1.03, 1.46)
Chronic disease count	0.99 (0.93, 1.04)	1.04 (0.98, 1.10)
ADL limitations (0–28)	0.99 (0.98, 1.00)	1.00 (0.99, 1.01)
IADL limitations (0–48)	0.99 (0.98, 1.00)	1.00 (1.00, 1.01)
Cognitive function (0–7)	1.01 (0.95, 1.07)	0.92** (0.87, 0.98)
Depressive symptoms (0–14)	1.00 (0.94, 1.06)	1.02 (0.97, 1.07)
Live alone	0.83 (0.68, 1.02)	0.98 (0.82, 1.18)
Social isolation		
No decline	Reference	Reference
Decline, not being depressed	0.56*** (0.43, 0.73)	0.80* (0.66, 0.97)
Decline, being depressed	0.48*** (0.36, 0.64)	0.88 (0.73, 1.05)
Initial program status		
Medicaid Waivers	Reference	Reference
Medicaid ineligible	0.70 (0.40, 1.21)	0.77 (0.55, 1.09)
OSA	0.72* (0.55, 0.95)	0.85 (0.66, 1.09)
Nursing Facility Transition	0.25*** (0.18, 0.34)	0.61*** (0.52, 0.72)
Enrollment year		
2008	Reference	Reference
2009	0.68** (0.52, 0.90)	0.79** (0.68, 0.93)
2010	0.63** (0.48, 0.83)	0.59*** (0.46, 0.75)
2011	0.58*** (0.46, 0.72)	0.61*** (0.49, 0.74)
2012	0.64** (0.46, 0.88)	0.68* (0.50, 0.93)

Notes: ADL = activities of daily living; IADL = instrumental activities of daily living; NH = non-Hispanic; OSA = Office of Services to the Aging; PCP = primary care physician.
***$p < .001$. **$p < .01$. *$p < .05$.

hospitalizations among racial/ethnic minority HCBS clients. Previous research showed an increased risk of hospital admission among those who transitioned from nursing homes to community-based settings compared to those who remained in nursing homes (Bardo et al., 2014; Wysocki, Kane, Dowd, et al., 2014). Similarly, we found that the NFTP participants had a 287% and 135% higher risk of being in the "decreased" and "frequent" groups (vs "never") in comparison to Medicaid Waivers users. This finding may reflect difficulties in handling clinical issues among informal caregivers and generally less available medical services in community settings, compared to institutional settings (Golden et al., 2010; Gruneir et al., 2018; Schamess et al., 2017; Wysocki, Kane, Golberstein, et al., 2014). Our study also revealed that NFTP participants also had a 75% lower risk of being in the "frequent" group than the "decreased" group, indicating that not all

remained at persistent risk of hospitalization over an extended period.

We focused on the number of services as a consistent and straightforward way of gauging resource adequacy across geographic areas. We did not capture differences in the quality of services provided by physicians and social service organizations that may influence the hospital trajectory. The quality of care that older adults received is an important factor for vulnerable older adults' outcomes (Higashi et al., 2005). However, care quality is a more complex concept, and there is no consistent definition/measure for diverse patients (National Quality Forum, 2016; Schultz et al., 2012). Relatedly, policy implications for care density are much more straightforward to develop and implement than strategies to improve care quality.

Scholars suggested the importance of identifying and intervening places (i.e., local infrastructure) to reduce avoidable utilization of costly health services and improve health equity (Fichtenberg et al., 2019; Muenchberger & Kendall, 2010). Our study demonstrates that the number of social service organizations can potentially be a useful place-based marker for identifying and reducing the most vulnerable groups among HCBS. Geographic differences in social care resources can inform the development of environmental risk assessment tools in care management programs in either community or hospital settings. By using the risk assessment tool, case managers and other health care providers may identify HCBS who are at the higher risks of reducing repeated hospitalizations and communicate with older adults about unmet needs, and devise a plan of action, such as referring adequate resources (e.g., supplementary programs for supportive services). The replication of our study is needed to increase the validity of our measures in multiple geographic scales or regions, to develop and inform place-based intervention among older adults in HCBS settings.

Study findings should be interpreted in light of its limitations. First, due to the insufficient information on disease characteristics at the time of hospitalization, we could not determine which hospitalizations were potentially preventable. The epidemiology, causes, and potential remedies of preventable hospitalization likely differ from necessary hospitalizations. Similarly, we lack hospitalization information when the assessments were more than 90 days apart. We assumed individuals had no inpatient admission as we found no evidence suggesting the gaps caused a bias in study findings. There was no significant difference in gaps across hospitalization groups. Moreover, HCBS programs are designed to monitor participants' care needs, and hospitalization events often demand services during the post-acute care phase (which would trigger assessments). Second, we could provide more refined implications about the uneven distribution of social service organizations and its association with hospitalization trajectories if we knew whether social service organizations offer social engagement opportunities versus preventive medical care services. Third, we did not include the type or the amount of home care service received, a potential mediator in the pathway between resource density and the outcome. Because home care services are provided based on each participant's clinical characteristics (James et al., 2015), the impact of excluding service utilization-related variables would be minimal. Finally, rural areas or other states have different financial, legal, and regulatory incentives for hospitalization. Thus, our findings may not be generalizable to rural or non-Michigan HCBS population.

Older adults receiving HCBS support through joint federal and state programs will likely continue and grow. Repeated hospitalization may indicate their unmet medical and social care needs. Living in areas with sparse formal resources increased the risk of frequent hospitalization over an extended period among older HCBS recipients. Health policymakers, case managers, and other health care providers may address key environmental markers identified here to mitigate risks of repeated hospitalizations.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None declared.

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Author Contributions

M. H. Kim planned the study, performed all statistical analyses, and wrote the first draft of the manuscript. X. Xiang revised the manuscript critically for intellectual content and approved the final submission.

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