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Research Article

Disparities in Post-Stroke Rehabilitation Service Utilization among Commercially Insured and Medicare Advantage Patients

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Abstract

Background: Studies highlight that post-stroke rehabilitation services are underused in the United States, with limited knowledge about the determinants affecting the use of outpatient and home-based rehabilitation post-discharge. This study aims to examine the associations between socio-demographic factors and the use patterns of community-based stroke rehabilitation services. **Methods:** A retrospective matched cohort study was conducted targeting commercially insured and Medicare Advantage (MA) populations diagnosed with stroke from January 2011 to December 2018. The primary outcome was the utilization of community-based stroke rehabilitation services in two years of post-discharge, with secondary outcomes focusing on the frequency and duration of service use. Socio-demographic factors assessed included age, sex, neighbourhood racial composition, median household income, rurality of residence, and insurance type. **Results:** Among 11,787 stroke survivors identified, 51.9% were female, 79.9% were older than 65 years, and 79.4% were MA enrolees. Of these, 2,098 received community-based rehabilitation services. Females, rural residents, and MA enrolees were more likely to use these services. Stroke survivors living in rural areas utilized more time per session, and MA enrolees had a higher frequency but shorter duration of visits. **Conclusion:** This study shed lights on the disparities in the utilization of community-based rehabilitation services among stroke survivors, underscoring the need for further research to quantify and address these disparities to enhance the availability and quality of community rehabilitation.

Keywords: Stroke; Rehabilitation; Community; Utilization; Disparity

Introduction

Stroke remains one of the leading causes of serious long-term disability in the United States (US). Utilizing rehabilitation services after a stroke is associated with improved functional outcomes, and increases likelihood of regaining independence to achieve a higher quality of life by minimizing the limitations of Activities of Daily Living (ADLs) regardless of the recovery stages [1-5]. Community-based stroke rehabilitation, i.e., rehabilitative care provided in patients' homes or outpatient settings, is a cost-effective alternative to facility-based rehabilitation as it reduces length of stay, saves medical expenses, and improves the quality of life for patients and caregivers with comparable clinical outcomes [6-10]. Since nearly 40% of stroke survivors experience challenges in performing basic ADLs (i.e., dressing) and more than half have difficulties performing instrumental ADLs (i.e., preparing meals), these services are necessary to reduce the likelihood of long-term impairment [11,12]. Yet, outpatient rehabilitative services are highly under-utilized among stroke patients [13,14]. It is estimated that nearly 50% of stroke patients are discharged to home without a referral to rehabilitation services [15-17]. Less than one-third of stroke survivors report using outpatient- or home-based rehabilitative care [18,19].

It is widely recognized that the likelihood of receiving post-stroke care varies by age, sex, medical complications, comorbidities, insurance, and environmental factors [20]. However, prior research focusing on community-based stroke rehabilitation is limited and lacks consensus [19,21-24]. The relationship between Socioeconomic Status (SES) and use of community-based stroke rehabilitation is also mixed and unclear [17,25,26]. A systematic review concluded that patients living in rural areas had lower access to most type of stroke care, including pre-hospital assessment, provision of thrombolysis, and post-discharge planning [27]. However, differences in the utilization of community-based stroke rehabilitation by rurality remain unknown. This study contributes to literature by using a large, national sample of privately insured and Medicare Advantage (MA) enrolees to examine rural-urban differences in the utilization of post-stroke rehabilitation among community-dwelling stroke survivors.

Methods

Data source and study design

This analysis used the Optum's de-identified Clinformatics® Data Mart Database (CDM) – a large nationwide administrative health claims database for members of commercial and MA health insurance plans – to derive a sample of US adults who were diagnosed with a stroke between January 1st, 2011 and December 31st, 2018 [28]. Standardized administrative codes, including the International Classification of Diseases (ICD), Ninth/Tenth Revision, Clinical Modification diagnostic codes, Current Procedural Terminology (CPT) codes, Healthcare Common Procedure Coding System (HCPCS), and revenue codes, were used to identify stroke diagnosis and delivered procedures. Age, sex, residential zip code, and insurance type (commercial or MA) was extracted for each identified subject. Because race and ethnicity as well as income were not available, area-level information from the 2016-2020 American Community Survey (ACS) 5-Year Estimates Data Profiles was used as proxies. The University of Texas Health Science Center at Houston Institutional Review Board (IRB) deemed this study exempt from review and informed consent.

Study population

Patients hospitalized for ischemic stroke or intracerebral haemorrhage were identified with one or more primary and secondary diagnostic codes (Supplemental Table 1) using Emergency Room (ER) or inpatient claims. If an individual had more than one stroke diagnoses, we considered the earliest stroke event to minimize confounding as functional impairments are likely to be more severe if the patient had recurrent stroke [29]. Only patients aged 18 years and above with a minimum of 12 months continuous enrolment before the stroke hospitalization and 24 months after discharge were included. Prior studies defined rehabilitation eligibility based on qualitative evaluation of functional deficit and ability to participate in rehabilitative activities by a multidisciplinary discharge planning team. Since qualitative information is not available in administrative claims, we excluded patients if they did not survive hospitalization, if they were discharged to hospices, or if they stayed in any facilities, such as acute care units and long-term care facilities, beyond 90 days from the stroke onset. A 12-month washout period was applied to exclude patients who had a history of cerebrovascular disease, end-stage renal disease, cancer, pregnancy, organ transplantation, fall-related visits, or any missing data on patients' characteristics. The sample flow is illustrated in Figure 1.

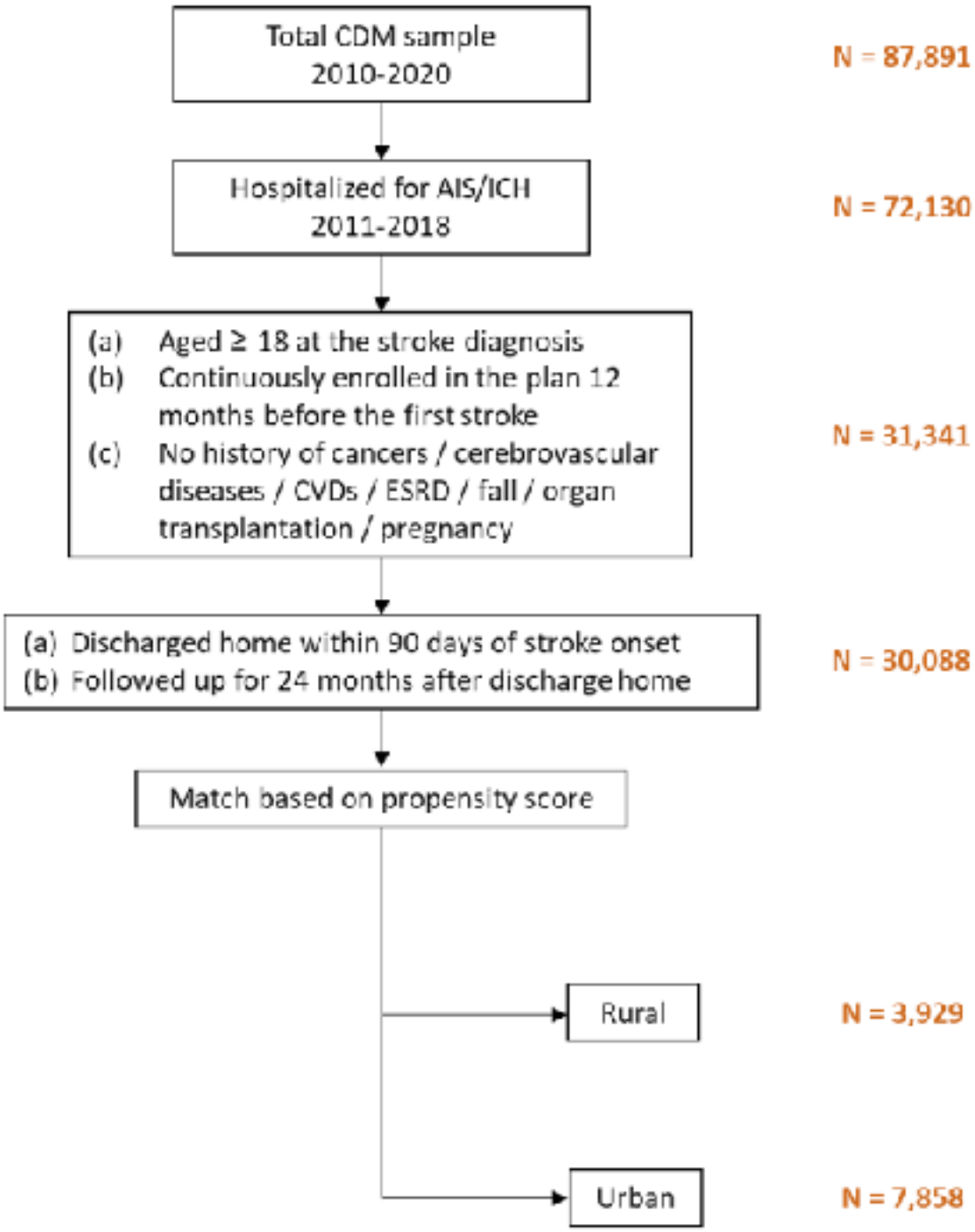

Figure 1: Retrospective matched cohort study design and sample flow chart. This figure illustrates the flow of the retrospective matched cohort study conducted in this research. The process began with total CDM enrolees in 2010-2020. Next, we identified enrolees who were hospitalized for acute ischemic or haemorrhagic stroke in 2011-2018 and applied the inclusion and exclusion criteria. Rural stroke survivors matched 1:2 to urban counterparts based on calculated propensity score.

Measurements

For each patient, the utilization of physical, occupational, and speech-language rehabilitation services within two years of discharge were identified by CPT/HCPCS/revenue codes (Supplemental Table 2). Type of bill codes were used to determine if the services were provided in outpatient clinics, at the patient's residence, or via telehealth. If patients had at least one observed service, the frequency and duration of service usage were also noted. The first and last dates of rehabilitation visits within a two-year period were identified. Frequency of service utilization was determined by dividing the total number of visits by the number of weeks between the first and last visits. Duration was defined as the average time, in minutes, spent per week in one-on-one direct therapy sessions. The length of each session was quantified using therapeutic services that were billed with time-based procedure codes, which allocate a service unit for every 15 minutes.

The residential area of stroke patients was identified using the 5-digit zip code information from the enrolment file cross-referenced with the 2010 US Department of Agriculture's Rural-Urban Commuting Area scheme. For this study, we collapsed area of residence into 2 categories based on the Health Resources & Services Administration definition: urban (codes 1 to 3) and rural (codes 4 to 10). Individual characteristics included age group at diagnosis (18-44, 45-64, and 65+ years), sex, and insurance type (commercial, MA, and other). Clinical characteristics were derived from medical claims files and included type of stroke (ischemic vs. haemorrhagic), and the length of stay, defined as the duration in days from admission to discharge from an acute care hospital for the incident stroke. Additionally, diagnoses of pneumonia and urinary tract infection which are common complications during the hospital stay were recorded. We also considered the long-term use of stroke-related medications, including anticoagulants and antiplatelet agents, as well as the receipt of rehabilitation services in inpatient settings (i.e., Inpatient Rehabilitation Facilities [IRFs], Skilled Nursing Facilities [SNFs]) prior to patients' return home. We evaluated the severity of stroke using the Stroke Administrative Severity Index (SASI) developed by Simpson, et al. SASI incorporates 7 indicators and the score ranges from 0 to 56 – score 0 is mild stroke, 1-6 as a moderate stroke, and 7 and above represent a severe stroke (Supplemental Table 3) [30]. A modified version of the Charlson Comorbidity Index developed by Goldstein et al. (2004) was applied to assess comorbid conditions. This modification is scored based on 16 disease categories at hospital discharge and dichotomized (low vs. high comorbidity) for analysis (Supplemental Table 4) [31]. Area-level racial composition (presented by the proportion of non-White) and median household income were extracted from the ACS and converted to quartiles for regression analysis.

Statistical analysis

To minimize confounding bias, each rural stroke survivor was matched to exact two urban survivors based on a propensity score constructed from age group, sex, and year of diagnosis. First, descriptive analyses summarized the characteristics of stroke survivors by rural-urban status. Kruskal-Wallies and chi-square tests compared the differences between urban and rural stroke survivors. Second, multivariable logistic regression models examined the likelihood of community-based rehabilitation use among stroke survivors, controlling for heterogeneity. Third, the frequency and duration of rehabilitation services use were calculated for a subset of stroke survivors over 24 months and compared by urbanicity/rurality using multivariable generalized linear models with a gamma-distributed error and log-link. Statistical significance was tested at $p<0.05$. All analyses were performed using SAS® 9.4 (Cary, NC).

Results

After applying the study criteria, the final cohort included a total of 11,787 stroke survivors with 7,858 from urban areas and 3,929 from rural. Characteristics of the overall stroke cohort and the comparison by residential area is presented in Table 1. The majority were aged 65 years and above. More than a half were women (51.9%, n=6,119), and most were enrolled in MA plans. On average, patients resided in areas where the mean proportion of non-White residents was 25.2%, and the median household income was $64,234 in the past 12 months. Ischemic stroke was the most common type (71.2%, n=8,386), and the average length of acute care stay was 7.1 days (standard deviation [SD]=9.0). Approximately 72.0% of survivors (n=8,481) had a mild stroke, and 64.4% (n=7,593) were identified as survivors with low comorbidity index values. About one in every seven patients (13.4%, n=1,579) was identified as long-term users of anticoagulants or antiplatelet agents. The racial composition, median household income, length of stay in the acute care hospital, use of stroke-related medications, and use of institutionalized stroke rehabilitation care were significantly different between rural and urban cohorts. Notably, rural stroke patients had a shorter mean length of acute care stay than urban patients, yet they had a higher use of stroke-related medications and inpatient rehabilitation therapies.

Characteristics	Total (N = 11,787) N (%)	Urban (n = 7,858) N (%)	Rural (n = 3,929) N (%)	*p*-value
Age at diagnosis				1.000
<45 years	231 (1.96)	154 (1.96)	77 (1.96)	
45-64 years	2,133 (18.10)	1,422 (18.10)	711 (18.10)	
≥65 years	9,423 (79.94)	6,282 (79.94)	3,141 (79.94)	
Sex				0.648
Male	5,668 (48.09)	3,767 (47.94)	1,901 (48.38)	
Female	6,119 (51.91)	4,091 (52.06)	2,028 (51.62)	
Percentage of non-White [Mean (SD)]	25.17 (21.21)	29.82 (21.89)	15.86 (16.17)	<0.001[a]
Median household income [Mean (SD)]	64,234.43 (24,154.86)	70,222.06 (26,318.58)	52,259.17 (12,247.12)	<0.001[a]
Insurance type				0.939
Commercial	2,151 (18.25)	1,441 (18.34)	710 (18.07)	
MA	9,358 (79.39)	6,232 (79.31)	3,126 (79.56)	
Other	278 (2.36)	185 (2.35)	93 (2.37)	
Stroke type				0.175
Acute ischemic stroke	8,386 (71.15)	5,548 (70.60)	2,838 (72.23)	
Haemorrhagic stroke	684 (5.80)	461 (5.87)	223 (5.68)	
Other	2,717 (23.05)	1,849 (23.53)	868 (22.09)	
Length of acute care stay [Mean (SD)]	7.08 (8.96)	7.31 (9.17)	6.61 (8.49)	0.003[a]
Pneumonia	609 (5.17)	413 (5.26)	196 (4.99)	0.537
Urinary tract infection	1,432 (12.15)	969 (12.33)	463 (11.78)	0.391
Stroke severity				0.252
Mild	8,481 (71.95)	5,655 (71.96)	2,826 (71.93)	
Moderate	2,367 (20.08)	1,557 (19.81)	810 (20.62)	
Severe	939 (7.97)	646 (8.22)	293 (7.46)	
Comorbidity				0.050
Low	7,593 (64.42)	5,014 (63.81)	2,579 (65.64)	
High	4,194 (35.58)	2,844 (36.19)	1,350 (34.36)	
Use of stroke-related medications	1,579 (13.40)	1,007 (12.81)	572 (14.56)	0.009[a]

Use of institutionalized stroke rehabilitation care	152 (1.29)	81 (1.03)	71 (1.81)	<0.001[a]
Abbreviations: MA: Medicare Advantage; SD: Standard Deviation. [a]Significant at $p<0.05$				

Table 1: Descriptive characteristics of overall stroke survivors and by rurality of residence.

During the 24-month post-discharge follow up, only 2,098 stroke survivors received community-based rehabilitation services (178 per 1,000 survivors). The use of community rehabilitation care was significantly higher in rural than urban survivors (224 vs. 155 per 1,000 stroke survivors, p<0.01). After controlling for covariates, results indicated stroke survivors living in rural areas were 23% more likely to use rehabilitation care in community settings than their urban counterparts (adjusted rate ratio [aRR]=1.23, 95% confidence interval [CI]=1.12-1.35), as shown in Table 2. Female survivors had a higher likelihood of utilizing community stroke rehabilitation services compared with males (aRR=1.13, 95% CI=1.05-1.22). Survivors living in neighbourhoods with more racial minorities (higher proportion of non-White) were less likely to use rehabilitation services (quartile 3 [Q3] vs. Q1: aRR=0.72, 95% CI=0.64-0.81; Q4 vs. Q1: aRR=0.79, 95% CI=0.70-0.89). The likelihood of utilizing stroke rehabilitative services in community settings decreased in order of increasing quartile of median household income (Q2 vs. Q1: aRR=0.90, 95% CI=0.82-0.99; Q3 vs. Q1: aRR=0.83, 95% CI=0.74-0.93; Q4 vs. Q1: aRR=0.75, 95% CI=0.65-0.85). Commercially insured individuals were less likely to receive community stroke rehabilitation services compared with MA enrolees (aRR=0.78, 95% CI=0.67-0.90). The likelihood of using rehabilitative services increased with the length of acute care stay (Q2 vs. Q1: aRR=1.49, 95% CI=1.24-1.79; Q3 vs. Q1: aRR=1.76, 95% CI=1.49-2.09; Q4 vs. Q1: aRR=2.74, 95% CI=2.30-3.26). Survivors with a moderate stroke were more likely to receive rehabilitative therapies than those with a mild stroke (aRR=1.14, 95% CI=1.04-1.25). Patients who received institutionalized stroke rehabilitation care were also more likely to use similar care in community settings (aRR=1.26, 95% CI=1.00-1.60).

Characteristics	aRR[a]	95% CI
Rural (ref. urban)	1.23	1.12 – 1.35 [b]
Age at diagnosis		
< 45 years (ref. ≥ 65)	0.76	0.51 – 1.13
45-64 years (ref. ≥ 65)	1.09	0.96 – 1.23
Female (ref. male)	1.13	1.05 – 1.22 [b]
Percentage of non-White		
Lower-middle quartile (ref. lowest)	0.93	0.84 – 1.03
Upper-middle quartile (ref. lowest)	0.72	0.64 – 0.81 [b]
Highest quartile (ref. lowest)	0.79	0.70 – 0.89 [b]
Median household income		
Lower-middle quartile (ref. lowest)	0.90	0.82 – 0.99 [b]
Upper-middle quartile (ref. lowest)	0.83	0.74 – 0.93 [b]
Highest quartile (ref. lowest)	0.75	0.65 – 0.85 [b]
Commercial insurance (ref. MA)	0.78	0.67 – 0.90 [b]
Haemorrhagic stroke (ref. ischemic)	0.86	0.73 – 1.02
Length of acute care stay		
2 days (ref. 1 day)	1.49	1.24 – 1.79 [b]
3-7 days (ref. 1 day)	1.76	1.49 – 2.09 [b]
≥ 8 days (ref. 1 day)	2.74	2.30 – 3.26 [b]
Pneumonia	0.99	0.85 – 1.15
Urinary tract infection	1.01	0.91 – 1.13

Stroke severity		
Moderate (ref. mild)	1.14	1.04 – 1.25 [b]
Severe (ref. mild)	1.04	0.92 – 1.19
High comorbidity (ref. low)	1.07	0.98 – 1.15
Use of stroke-related medications	1.03	0.93 – 1.14
Use of institutionalized stroke rehabilitation care	1.26	1.00 – 1.60 [b]

Abbreviations: MA: Medicare Advantage; aRR: adjusted Rate Ratio; CI: Confidence Interval; ref: Reference.

[a]Rate ratios were adjusted for age group, sex, zip code-level racial composition, median household income, type of insurance, stroke type, length of hospital stay, presence of pneumonia during hospitalization, presence of urinary tract infection during hospitalization, level of stroke severity, level comorbidity, long-term use of stroke-related medications, and use of institutionalized stroke rehabilitation services.

[b]Significant at $p < 0.05$

Table 2: Likelihood of receiving community-based stroke rehabilitation services.

A subset of 2,074 stroke survivors who received community-based rehabilitation care were followed for 24 months to examine the frequency and duration of use. Specifically, 873 were from rural, and 1,021 were from urban areas. Overall, the average number of visits to community stroke rehabilitation was 2.0 times per week for both urban and rural dwellers, and the median duration of billable therapy time was 43.1 minutes per week. A higher frequency of use was attributed to the racial composition of survivors' residence, type of insurance, length of acute care stay, and stroke severity, as shown in Table 3. Notably, after controlling for socioeconomic and clinical factors, the location of survivors' residence was a significant indicator for rehabilitation duration. Survivors residing in rural areas utilized 18% more time for rehabilitative therapies in community settings every week (aRR=1.18, 95% CI=1.04-1.32). Remarkably, stroke survivors who enrolled in commercial insurance plans had nearly 4 times the duration compared with MA enrolees (aRR=3.92, 95% CI=3.20-4.82). Moreover, longer length of acute care stays and fewer comorbid conditions were associated with more time for community rehabilitation services in stroke survivors (Table 4).

Characteristics	**aRR[a]**	**95% CI**
Rural (ref. urban)	0.97	0.91 – 1.04
Age at diagnosis		
< 45 years (ref. ≥ 65)	0.77	0.58 – 1.03
45-64 years (ref. ≥ 65)	0.95	0.86 – 1.05
Female (ref. male)	1.03	0.97 – 1.09
Percentage of non-White		
Lower-middle quartile (ref. lowest)	1.02	0.94 – 1.09
Upper-middle quartile (ref. lowest)	0.97	0.89 – 1.05
Highest quartile (ref. lowest)	0.90	0.83 – 0.98
Median household income		
Lower-middle quartile (ref. lowest)	0.98	0.91 – 1.05
Upper-middle quartile (ref. lowest)	0.97	0.89 – 1.06
Highest quartile (ref. lowest)	0.98	0.88 – 1.08
Commercial insurance (ref. MA)	0.54	0.48 – 0.61 [b]
Haemorrhagic stroke (ref. ischemic)	0.93	0.83 – 1.05
Length of acute care stay		
2 days (ref. 1 day)	1.06	0.93 – 1.20

3-7 days (ref. 1 day)	1.08	0.96 – 1.21
≥ 8 days (ref. 1 day)	1.32	1.17 – 1.49 [b]
Pneumonia	1.01	0.90 – 1.13
Urinary tract infection	0.97	0.90 – 1.05
Stroke severity		
Moderate (ref. mild)	1.08	1.01 – 1.16 [b]
Severe (ref. mild)	1.13	1.03 – 1.25 [b]
High comorbidity (ref. low)	0.97	0.91 – 1.02
Use of stroke-related medications	0.99	0.92 – 1.07
Use of institutionalized stroke rehabilitation care	1.06	0.88 – 1.28

Abbreviations: MA: Medicare Advantage; aRR: adjusted Rate Ratio; CI: Confidence Interval; ref: Reference.

[a]Rate ratios were adjusted for age group, sex, zip code-level racial composition, median household income, type of insurance, stroke type, length of hospital stay, presence of pneumonia during hospitalization, presence of urinary tract infection during hospitalization, level of stroke severity, level comorbidity, long-term use of stroke-related medications, and use of institutionalized stroke rehabilitation services.

[b]Significant at $p<0.05$

Table 3: Factors associated with frequency of community-based stroke rehabilitation use.

Characteristics	aRR[a]	95% CI
Rural (ref. urban)	1.18	1.04 – 1.32 [b]
Age at diagnosis		
< 45 years (ref. ≥ 65)	1.43	0.87 – 2.33
45-64 years (ref. ≥ 65)	1.10	0.92 – 1.31
Female (ref. male)	0.97	0.88 – 1.08
Percentage of non-White		
Lower-middle quartile (ref. lowest)	1.07	0.94 – 1.22
Upper-middle quartile (ref. lowest)	1.06	0.92 – 1.23
Highest quartile (ref. lowest)	1.03	0.89 – 1.20
Median household income		
Lower-middle quartile (ref. lowest)	0.92	0.81 – 1.05
Upper-middle quartile (ref. lowest)	1.01	0.86 – 1.18
Highest quartile (ref. lowest)	1.07	0.90 – 1.27
Commercial insurance (ref. MA)	3.92	3.20 – 4.82 [b]
Haemorrhagic stroke (ref. ischemic)	0.86	0.71 – 1.06
Length of acute care stay		
2 days (ref. 1 day)	1.20	0.96 – 1.50
3-7 days (ref. 1 day)	1.28	1.04 – 1.57 [b]
≥ 8 days (ref. 1 day)	1.78	1.43 – 2.21 [b]
Pneumonia	0.97	0.79 – 1.18
Urinary tract infection	1.05	0.91 – 1.21

Stroke severity		
Moderate (ref. mild)	1.11	0.99 – 1.25
Severe (ref. mild)	1.13	0.95 – 1.34
High comorbidity (ref. low)	0.87	0.79 – 0.97 [b]
Use of stroke-related medications	1.04	0.92 – 1.19
Use of institutionalized stroke rehabilitation care	0.75	0.52 – 1.08

Abbreviations: MA: Medicare Advantage; aRR: adjusted Rate Ratio; CI: Confidence Interval; ref: Reference.

[a]Rate ratios were adjusted for age group, sex, zip code-level racial composition, median household income, type of insurance, stroke type, length of hospital stay, presence of pneumonia during hospitalization, presence of urinary tract infection during hospitalization, level of stroke severity, level comorbidity, long-term use of stroke-related medications, and use of institutionalized stroke rehabilitation services.

[b]Significant at $p<0.05$

Table 4: Factors associated with duration of community-based stroke rehabilitation use.

Discussion

Our findings suggest residential location of stroke survivors is associated with community rehabilitation use in office- and home-based settings. We found approximately 18% of stroke survivors used community-based rehabilitation services which is similar to Freburger, et al. who found a 17% utilization rate and Ayala, et al. and Bettger who both found <30% of stroke survivors were referred to community rehabilitation services after home discharge [15,18]. These findings provide substantial evidence that community-based rehabilitation services are significantly under-utilized.

Despite evidence of persistent under-utilization, approximately 3 million non-institutionalized stroke survivors report some form of some functional limitations [32]. To achieve a successful transition from inpatient to home settings, referring to and utilizing community-based rehabilitation services are critical for ongoing recovery of stroke survivors [33]. The results presented herein show that the likelihood of rehabilitation service use was higher among rural residents relative to their urban counterparts. This finding stands in contrast to a number of previous studies, which suggested that stroke patients in rural areas were less likely to have access to rehabilitation services regardless of care settings [19,34,35]. Historical data has shown that the limited access to these services was primarily attributed to a shortage of specialists in rural regions [36]. One potential explanation for our findings is that Medicare beneficiaries living in rural areas report more home health episodes in comparison to those in urban areas [37]. Moreover, rural enrolees in the commercial insured and MA populations may possess comparable or superior SES to their urban counterparts. In this case, access to stroke rehabilitation care after being discharged home is affordable and feasible for rural survivors, and this geographical trend of patient access may continue in the future particularly with the proliferation of MA plans. It is worth noting that more recent studies found that a majority of rural patients had appropriate geographic access to stroke services, and the gap between rural and urban areas in terms of access to high-quality stroke care was reduced substantially in the past decade, suggesting a positive trend towards improving healthcare accessibility in rural areas [38,39].

This study also shows that rural stroke survivors engage in more active, goal-directed, face-to-face therapies than urban survivors after controlling for other factors. To our knowledge, no prior research has examined geographic differences in duration of community-based rehabilitation. Since rural residents reported traveling longer distances to visit their healthcare providers than those living in urban areas, regardless of their health condition, they may prefer having more extensive therapies during each office visit due to the significant travel burden required for each appointment [40,41]. It is notable that stroke survivors in a commercial insurance plan have fewer rehabilitation visits but longer sessions every week compared to MA enrolees. This disparity may be attributed to a younger cohort in the commercial insurance group who are likely to return to work following acute care, limiting their availability to attend rehabilitative sessions as frequent as MA enrolees. Additionally, these young enrolees may undergo prolonged and intensive therapies each visit due to a better functionality and neuroplasticity at a younger age [42]. On the other hand, MA plans employ a payment model incentivizing provider to discharge patients early to homes or to a low-cost post-acute care setting, and required pre-authorization for services in an effort to limit the patient use of high-cost services [43]. Although community-based rehabilitative services are not high-cost, pre-authorization and other managed care measures may contribute to the significantly shorter duration of stroke rehabilitation observed in MA enrolees.

Limitations

This study may be prone to selection bias due to the database utilized. The population studied in this research were insured individuals who may have more financial resources than the general population [44]. Thus, the findings may not be readily generalizable to some populations, including traditional Medicare and Medicaid beneficiaries as well as the uninsured population. Second, some enrolees had multiple zip codes on record, suggesting they relocated multiple times during the study period. While an ad-hoc analysis showed that very few patients moved between rural and urban areas, we acknowledge that relocation may have led to variation in residential rurality. Third, some individual-level information including race and ethnicity, SES, health behaviors, and other clinical indicators is not available due to privacy constraints. While zip code level information from the ACS and other validated indices (i.e., stroke severity, comorbidity) were incorporated to adjust for demographic/SES and health status, respectively, we acknowledge the inclusion of this information may have impacted results. Last, we are unable to identify the location of providers, thus cannot quantify the distance between patients and rehabilitation care facilities which likely influenced both the frequency and duration of services received. Tran, et al. addressed this limitation through the use of a Google search API. However, we could not ascertain the operational periods of rehabilitation facilities over the past decade corresponding to when the utilization was examined in our study [45].

Conclusion

Our findings showed that community-based stroke rehabilitation services are largely under-utilized by non-institutionalized stroke survivors. Less than one in five stroke survivors received community-based rehabilitation care between 2011 and 2020. This study also highlighted significant differences in rehabilitation utilization and the pattern of utilization between the survivors residing in rural versus urban areas. We found that rural stroke survivors have proportionately higher utilization and duration of utilization of rehabilitative therapies compared with their urban counterparts. This differential may be attributable to unobserved individual factors (i.e., age, SES) or insurance coverage allowances (i.e., MA plan restrictions). Future research is needed to determine whether these observed geographic differences in the use of community-based stroke rehabilitation services persist in other populations, and whether insurance restrictions explain any of the observed differences.

Ethical Considerations

The University of Texas Health Science Center at Houston Institutional Review Board (IRB) deemed this study exempt from review and informed consent.

Conflict of Interest

The authors have no conflict of interest to disclose related to the study.

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