Published in final edited form as:

Arch Phys Med Rehabil. 2019 July ; 100(7): 1218–1225. doi:10.1016/j.apmr.2018.12.028.

Use of Hospital-Based Rehabilitation Services and Hospital Readmission following Ischemic Stroke in the United States

Amit Kumar, MPH, PhD¹, Linda Resnik, PT PhD^{2,3}, Amol Karmarkar, MPH, PhD⁴, Janet Freburger, PT, PhD⁵, Deepak Adhikari, MS², Vincent Mor, PhD^{2,3}, and Pedro Gozalo, PhD^{2,3}

¹College of Health and Human Services, Northern Arizona University, Flagstaff, AZ ²Department of Health Services, Policy & Practices, School of Public Health, Brown University ³Providence Veterans Affairs Medical Center, Providence, Rhode Island ⁴University of Texas Medical Branch, Galveston, TX ⁵School of Health and Rehabilitation Science, University of Pittsburgh, PA

Abstract

Objective: To examine the association between hospital-based rehabilitation service use and all-cause 30-day hospital readmission among patients with ischemic stroke.

Design: Secondary analysis of inpatient Medicare claims data using Standard Analytical File.

Setting: Acute Hospitals across the U.S.

Participants: From nationwide data, 88,826 Medicare fee-for-service beneficiaries aged 66 or older hospitalized for ischemic stroke between January–November, 2010.

Interventions: Hospital-based rehabilitation services were quantified using Medicare inpatient claims revenue center codes for evaluation (occupational therapy [OT] and physical therapy [PT]), as well as the number of therapy units delivered. Therapy minutes for both OT and PT services were categorized into none, low, medium, and high.

Main Outcome Measures: All-cause 30-day hospital readmission. A generalized linear mixed model was used to examine the effect of hospital-based rehabilitation services on 30-day hospital readmission, after adjusting for patient and hospital characteristics.

Results: In fully adjusted models, compared to patients who received no PT, we observed a monotonic inverse relationship between the amount of PT and hospital readmission; low PT: 30 minutes (OR= 0.90; 95% CI; 0.83–0.96), medium PT: >30 to 75 minutes (OR=0.89; 95% CI; 0.82–0.95) and high PT: >75 minutes (OR=0.86; 95% CI; 0.80–0.93).

Conclusion: Hospital-based physical therapy services was associated with lower risk of 30-day hospital readmission in patients with ischemic stroke.

Corresponding Author: Amit Kumar, MPH, PhD, College of Health and Human Services, Northern Arizona University, Flagstaff, AZ, amit.kumar@nau.edu, Phone:412-592-2062.

Conflict of Interest: None

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

Medicare; Rehospitalization; Physical therapy; Occupational Therapy; Acute Care; Older Adults; Hemiplegia; value-based care

The Hospital Readmission Reduction Program (HRRP) and the recent inclusion of stroke as one of the conditions for bundled payment models, have created additional incentives for acute hospitals to prioritize processes of care including the integration of early rehabilitation services.^{1,2} Such value-based payment initiatives may, on the other hand, incentivize cost containment by reducing the amount of rehabilitation care provided during acute hospitalization, which may adversely affect patient outcomes. Improving functional status through early initiation of rehabilitative care during acute hospitalization after stroke is critical to reduce hospital-acquired deconditioning and improve recovery. Yet, U.S. hospitals do not prioritize functional recovery by providing comprehensive rehabilitation services in acute settings.^{3–5} Physical and Occupational Therapists have a vital role in the interdisciplinary team that assists patients in their transition from acute to post-acute to community settings, and rehabilitation services delivered during acute stays play an important role in improving function in patients with stroke.⁶

Evidence to support role of rehabilitation services in patient's recovery and outcomes in acute settings is inadequate. To our knowledge, a few studies have yielded varying findings on the effect of rehabilitation services in the acute care settings on hospital readmission in patients with stroke.^{3, 7, 8} With respect to defining rehabilitation intensity using administrative data, quantification of rehabilitation is problematic. Limitations in U.S. based studies include that only certain states were examined and that the measure of PT and OT use was based on total charges which vary regionally and are imprecise measures of cost and PT and OT treatment dose. Lack of detailed information on the amount of hospital-based OT and PT services received in prior studies using administrative data has left important gaps in understanding the relationship between rehabilitation dose during the acute stay and outcomes such as hospital readmission. The objective of this study was to use a more precise methodological approach to examine the association between the amount of hospital-based rehabilitation services received and all-cause 30-day hospital readmission in patients with ischemic stroke.

Methods

Database:

Data sources included 2009–2010 Medicare inpatient 100% claims data using the Standard Analytical File (SAF), Master Beneficiary Summary File, the Provider of Services file, and the Chronic Condition Warehouse (CCW) data. The SAF file contains claims for all inpatient stays, including stays at acute hospitals and information about diagnostic conditions, surgical procedures, length of stay, and detailed revenue center codes for evaluation and treatment by occupational and physical therapists as well as the number of therapy units delivered. The Master Beneficiary Summary File contains information on beneficiaries' sociodemographic characteristics, and indicators for Medicare enrollment.

Because comorbidity indexes from inpatient claims do not adequately capture chronic conditions or predict patient functional status or hospital readmission,^{9, 10} we decided to use data from the Chronic Conditions Data Warehouse (CCW) to capture comorbidities.¹¹ The CCW has developed an algorithm based on particular diagnosis and procedure codes found on institutional and non-institutional claims across multiple care settings within a specified reference period (longer lookback) to identify chronic conditions.¹¹ The chronic condition data warehouse was used to retrieve the number of chronic conditions for the study cohort. The Provider of Services (POS) file includes hospital-level information about Medicare-certified hospitals such as urban setting, profit status, teaching status. We obtained median household income and household educational information for the patient's zip code of residence from the American Community Survey data (2010). Detailed information on the data sources is available in the data statement (supplemental table S1).

Ethics and Resource Sharing Statement:

The study was approved by the University Institutional Review Board with a waiver of consent for the use of secondary identifiable data. We had a Data Use Agreement approved by Centers for Medicare & Medicaid Services (DUA RSCH-2017–51217). This study is reported as per the STROBE guidelines (supplemental fig S1). Interested researchers may replicate the study obtaining the data and supporting information files from the CMS. To reproduce this study requires 100% Medicare inpatient claims data from the SAF files.

Participants:

The study sample consisted of Medicare beneficiaries with fee-for-service (FFS) **plan** aged 66 and older who were admitted to acute or critical access hospitals after January 1, 2010 and discharged by November 30, 2010, for a new, primary diagnosis of ischemic stroke using the International Classification of Diseases, Ninth Revision (ICD-9) codes 433.x1, 434.x1, and 436. In order to obtain a complete medical history and to assess readmissions, the sample was restricted to patients who had 12 months of continuous Medicare FFS enrollment before and one month after the index hospitalization. Patients enrolled in Medicare based on disability, who had a history of prior stroke in the past twelve months, who left the hospital against medical advice, transferred to another acute care hospital, or died during the index hospitalization were excluded from our sample (Figure 1). Also excluded were patients who transferred from another hospital and those with non-emergent admissions, because those patients were presumed to have different condition severity and may have experienced a different process of care. Furthermore, to avoid competing risk due to death with readmission, we excluded patients discharged to hospice and those who died within 30 days of discharge from the hospital. The final sample comprised 88,826 patients who received care in the acute hospitals for ischemic stroke.

Variables

Patient-level demographic characteristics and hospital-level variables were included in analyses. Age was categorized into 4 levels: 66–70, 71–75, 76–80, 81–85, and >85 years. Dual eligibility was classified as “yes” if the beneficiary was enrolled in both Medicare and Medicaid. These variables were extracted from the Master Beneficiary Summary File. At the

zip-code level, we included patient's residential zip code median household income and household education. We obtained median household income and household educational information for the patient's zip code of residence from the American Community Survey data. Both zip level income and education were categorized into four levels based on quartile distribution (low: 1 to 4: high).

Covariates:

To control for case-mix and other confounders, we included lengths of stay during acute hospitalization, intensive care unit (ICU) stay, receipt of tissue plasminogen activator (tPA), use of a feeding tube, receipt of care from speech-language pathologists, and number of comorbidities from the CCW. Length of stay in hospital was used as continuous variable in days, and ICU stay treated as a dichotomous variable. We identified tPA and feeding tube use by ICD9-CM procedure codes from the SAF file. We created a dichotomous variable of prior hospitalization based on any acute inpatient hospitalization in last 12 months except for stroke. Patient level variables also included post-acute discharge destination. Post-acute discharge destination was classified as inpatient rehabilitation facility (IRF), skilled nursing facility (SNF), and home healthcare (HH) (with home, no HH as the reference group) after index acute hospitalization. The Brown University Residential History File (RHF) method was used to determine post-acute discharge destination. The Brown University RHF was built using the Master Beneficiary Summary File, Medicare Part A and B claims files (except the Carrier file), and resident assessment data from Inpatient Rehabilitation Facilities (IRF-PAI), Skilled Nursing Facilities (MDS), and Home Health (OASIS), to track the healthcare utilization and location history of the beneficiary within a pre-specified calendar period.¹² Hospital-level variables included for-profit status, urban/rural, teaching status, hospital with inpatient rehabilitation unit or swing beds, and volume of stroke patients. We used Medicare provider number along with alpha character (R or T) to identify hospital-based subprovider or rehabilitation unit.

The utilization of hospital-based PT and OT was the primary variable of interest. Revenue center codes for evaluation and treatment were used to calculate the amount of PT and OT delivered during the stay. We assigned 15 minutes for each treatment unit and 30 minutes for each evaluation unit. We summed the minutes for PT and OT evaluation and treatment separately and then categorized the minutes into none, low, medium, and high categories based on the tertile distribution. To adjust for the confounding effect of a patient receiving more therapy with a longer stay, we included length of stay in our regression models. PT categories based on tertile distribution for the entire hospital stay were: low: 30 minutes, medium: >30 to 75 minutes, and high: >75 minutes. OT categories were: low: 30 minutes, medium: >30 to 60 minutes, and high: > 60 minutes. Detailed information on revenue center codes for OT and PT services is available in the online- Data Supplement (supplemental table S2).

Outcome:

The primary outcome was all cause, hospital readmissions (as defined by CMS) using the 30-day period from the date of discharge of the index acute hospitalization.¹ This

readmission measure was retrieved from the SAF and dichotomized into yes or no categories.

Statistical Analysis

We generated descriptive statistics stratified by 30-day readmission. We reported continuous variables with means $\pm$ SDs and categorical variables with counts (percentages).

Acknowledging the nested structure of the data, where patients (level 1) are nested in hospitals (level 2), we constructed generalized linear mixed models that adjust for within-cluster correlation to examine the relationship of rehabilitation use with readmission, controlling for patient-level characteristics, hospital characteristics, and post-acute discharge destination. In addition to the analysis with our main cohort, we also conducted a sensitivity analysis that included patients who were transferred from another hospital. Patients transferred from another acute care hospital in our cohort are likely sicker and may have different disease trajectory, which may influence processes of care and patients' outcomes. All statistical analyses were performed using SAS 9.4 (SAS Inc., Cary, NC, USA).

Results

Fourteen percent of patients were rehospitalized within 30-days following discharge from an acute care hospital. The bivariate analyses indicated (Table 1) that rehospitalized individuals were more likely to be older, Black, Medicare-Medicaid dual enrolled patients, and with higher number of chronic conditions, length of stay, and certain hospital-level variables. Table 2 shows the results of the generalized linear mixed models predicting 30-day hospital readmission. After, controlling for demographic, patient comorbidities, discharge location and hospital characteristics, we observed a significant inverse association between PT services and 30-day readmission: the greater the amount of PT services provided, the lower the odds of rehospitalization compared to no-therapy. No significant associations were found between receipt of OT services, speech-language pathology (therapy), and likelihood of readmission.

Several demographic measures and stroke-related clinical severity as indicated by history of hospitalization in the last 12 months, having more comorbidities (2), longer lengths of stay, having an ICU stay, or having a feeding tube were associated with higher odds of rehospitalization. Patients receiving tPA had 11% lower odds of rehospitalization (OR 0.89, 95% CI; 0.81 to 0.98) compared to non-tPA recipients.

Discharge status was also associated with risk of readmission. Relative to patients discharged home without HH, those discharged to other types of post-acute care had higher odds of readmission. Patients treated at SNFs were the most likely to be readmitted (OR, 1.28, 95% CI; 1.20 to 1.35), followed by those treated in IRF (OR, 1.18, 95% CI; 1.16 to 1.25) and those discharged home with HH (OR, 1.14, 95% CI; 1.07 to 1.21) the least likely. Some hospital characteristics including patients treated in a hospital with inpatient rehabilitation unit had 8% lower odds of rehospitalization (OR, 0.92, 95% CI; 0.88 to 0.96). Sensitivity analyses conducted after including patients transferred from another hospital

revealed no change in the pattern of results except for black patients who had higher odds of readmission (Supplemental Table S3).

Discussion

To our knowledge, this is the first study to examine relationships between hospital-based rehabilitation services and patient outcomes using a population-based sample of patients admitted to acute hospitals after an ischemic stroke. Our study overcomes the limitation of prior studies by quantifying rehabilitation utilization based on units/minutes of service associated with PT- and OT-specific revenue center codes and more importantly providing a better measure of therapy intensity that is independent of regional differences in charges submitted by providers. Consistent with our hypothesis, the intensity of hospital-based PT services was associated with a decreased risk of 30-day hospital readmission; however, we found no association between OT services and 30-day hospital readmission.

Our method provides an estimate of the amount of therapy delivered and establishes an association between PT intensity and likelihood of hospital readmission. This result was consistent with findings from previous studies, which used state-level inpatient data from a few states.^{3, 7} Andrew et al. found that intensity of hospital-based therapy services (PT and OT) was associated with a reduced risk of 30-day hospital readmission in patients with stroke.³ Our findings on association between OT and readmission differ from those of a recent study by Rogers and colleagues, which used Medicare claims data from MedPAR to quantify rehabilitation costs, and found that more hospital spending on OT was associated with lower readmission rates. One plausible reason for these apparent differences in findings is that Roger's study focused on patients with three medical conditions: heart failure, pneumonia, and acute myocardial infarction, while our patients had ischemic stroke.¹³ It is possible that these patient populations benefit differentially from OT services. Our study used revenue center codes to estimate the number of minutes of therapy provided, whereas prior studies estimated therapy amount using charges. Additionally, our study provides national findings in patients with ischemic stroke, overcoming a generalizability limitation of prior studies.

Our findings clearly demonstrate that higher intensity of rehabilitation services in the acute setting has a major impact on downstream outcomes, such as hospital readmission. We believe that the mechanism underpinning the relationship between PT and readmission is two-fold. First, physical and occupational therapists play vital roles in addressing functional status, known to be one of the strongest predictors of hospital readmission.¹⁴ Secondly, physical and occupational therapists play a crucial role in preparing patients for the next level of post-acute care and participating in discharge planning. We acknowledge that significant variation exists in the discharge planning process, by region, and other provider-level factors, however, such integration of rehabilitation professionals is critical, and needs to be investigated through primary data collection methods.

This study also provided information on the impact of continuity of acute and post-acute care by a single provider (hospital with IRF unit) on hospital readmission. Patients who received treatment in a hospital that also owned an IRF unit had an 8% lower risk of

rehospitalization. Our study findings are consistent with previous work demonstrating the positive impact of hospital-IRF integration on patient outcomes.¹⁵ Having a single provider for both acute and post-acute care promotes more seamless exchanges of clinical information and care plan between a hospital and an IRF,¹⁵ a process critical in reducing rehospitalization. These findings have implications for bundled payment programs, as health systems struggle to integrate acute/post-acute care to reduce cost and fragmentation of care to improve patient outcomes.² Thus, hospitals with integrated inpatient post-acute care facilities, in turn, may be proponents of providing upstream rehabilitation services to improve downstream (post-acute) outcomes.

Consistent with a previous study, we found that several patient- and hospital-level factors were associated with an increased risk of 30-day hospital readmission. Overall, dual enrollment in Medicare and Medicaid, more comorbidities (2), longer lengths of stay, ICU stays, and having a feeding tube were associated with increased risk of hospital readmission.^{16–18} Our study results are consistent with recent research and reiterate the importance of tPA in improving patient outcomes and reducing hospital readmission.¹⁷

Study Limitations:

Our study has a few limitations. First, we were unable to directly control for stroke severity and functional status in our analyses as this information is not captured in the Medicare claims data. Second, we acknowledge that post-acute discharge destination is significantly associated with readmissions. In this study, we used indicators for the selected post-acute care setting that partially account for the potential risk differential of patients discharged to different settings and the potentially different treatment in those settings, but our model did not directly account for selection bias and did not attempt to tease out the mediating effect of post-acute care destination on the association between hospital-based rehabilitation services and 30day readmission in this study. Future work needs to account for “effect modifiers” (e.g., post-acute discharge settings) on distal outcomes, such as hospital readmission. Third, our study cohort was limited to older Medicare enrollees on FFS plans with ischemic stroke thus; the results are not generalizable to younger stroke patients, those covered under Medicare Advantage plans or persons who had hemorrhagic stroke. We excluded persons with stroke who transferred from another acute care hospital because we believed that these patients might be more severely impaired with different disease trajectories. To ascertain whether this exclusion created any bias in our study, we conducted sensitivity analyses that included the patients who had transferred from another acute care facility. These analyses also (Supplemental Table S3) showed that higher use of PT is associated with lower readmission rates. Fourth, because our analysis was limited to the year 2010, we cannot evaluate and tease out the effect of the Hospital Readmission Reduction Program during the pre-penalty period. A recent paper using 2014 Nationwide Readmissions Database, reported similar readmission rate of 14.4% in all age group and 16.4% in older adults.¹⁹ We used 30 minutes for evaluation and therapy units together, which may augment the effect of therapy on patient outcomes slightly. However, in clinical practice, every patient who receives therapy should be evaluated first to identify problems, establish goals and a plan of care. Also, we only accounted for amount of therapy as a proxy for intensity. Future research is recommended to examine the content of the therapeutic intervention to determine

relationships between specific treatment (e.g. exercise, gait and balance training and education) and outcomes. Finally, our data do not include other confounders such as continuity of care for SNF/HH, outpatient visits or transitional care management that may influence patient outcomes. We did not have part B claims therefore, we were unable to adjust for this factor. Despite these limitations, we believe that our proposed method of using Medicare claims data in the SAF format provides researchers a new fruitful direction with which to examine utilization of rehabilitation services by using revenue center codes for PT/OT evaluation and therapy, to better estimate the actual therapy minutes and to examine the effectiveness of hospital-based rehabilitation services.

Conclusion:

Our study found a strong positive association between higher use of hospital-based physical therapy and lower 30-day hospital readmission rates in patients with ischemic stroke. The U.S. healthcare is moving from volume-based to value-based care. However, research focusing on processes of care is somewhat scarce, especially in the context of rehabilitation services utilization. Our study is one of the few that is addressing this critical aspect and provides a targeted direction for clinical trials and more importantly pragmatic clinical trials that are looking to improve care management of patients after stroke. Rehabilitation services vary significantly across hospitals and were underused in the U.S. Further studies are recommended using stroke registries linked with the health care system and claims data, which captures information on the timing of initiation of in-patient therapy, detail information on therapy units, and outpatient therapy. Results from this study will strengthen evidence supporting the value of hospital-based rehabilitation services in mitigating the risk of hospital readmission for patients with ischemic stroke.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Source of Funding: This research was supported by the NIH grant: R03 AG060345, P01 AG027296, K01 HD086290, and Foundation for Physical Therapy's Center on Excellence in Health Services and Health Policy Research and Training Grant. The views expressed herein are those of the authors and do not reflect the official policy or position of the Department of the Army, the US Department of Defense, the US Department of Veterans Affairs, or the US government.

References

1. National Quality Measures Clearinghouse. Stroke: Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate Following Acute Ischemic Stroke Hospitalization. 2015.
2. Center for Medicare and Medicaid Innovation (Innovation Center). BPCI Advanced 2018 [cited 2018 May 2]. Available from: URL: <https://innovation.cms.gov/initiatives/bpci-advanced>.
3. Andrews AW, Li D, Freburger JK. Association of Rehabilitation Intensity for Stroke and Risk of Hospital Readmission. *Phys Ther* 2015;95(12):1660–7. [PubMed: 26089042]
4. Freburger JK, Li D, Johnson AM, Fraher EP. Physical and Occupational Therapy From the Acute to Community Setting After Stroke: Predictors of Use, Continuity of Care, and Timeliness of Care. *Arch Phys Med Rehabil* 2018; 99(6):1077–1089. [PubMed: 28389108]

5. Freburger JK, Heatwole Shank K, Knauer SR, Montmeny RM. Delivery of physical therapy in the acute care setting: a population-based study. *Phys Ther* 2012;92(2):251–65. [PubMed: 22052948]
6. Yagi M, Yasunaga H, Matsui H, Morita K, Fushimi K, Fujimoto M et al. Impact of Rehabilitation on Outcomes in Patients With Ischemic Stroke. A Nationwide Retrospective Cohort Study in Japan. *Stroke* 2017;48(3):740–6. [PubMed: 28108619]
7. Burke JF, Skolarus LE, Adelman EE, Reeves MJ, Brown DL. Influence of hospital-level practices on readmission after ischemic stroke. *Neurology* 2014;82(24):2196–204. [PubMed: 24838793]
8. Chang KC, Hung JW, Lee HC, Yen CL, Wu CY, Yang CL et al. Rehabilitation Reduced Readmission and Mortality Risks in Patients With Stroke or Transient Ischemic Attack: A Population-based Study. *Med Care* 2018;56(4):290–8. [PubMed: 29419706]
9. Kumar A, Graham JE, Resnik L, Karmarkar AM, Deutsch A, Tan A et al. Examining the Association Between Comorbidity Indexes and Functional Status in Hospitalized Medicare Fee-for-Service Beneficiaries. *Phys Ther* 2016;96(2):232–40. [PubMed: 26564253]
10. Kumar A, Karmarkar AM, Graham JE, Resnik L, Tan A, Deutsch A et al. Comorbidity Indices Versus Function as Potential Predictors of 30-Day Readmission in Older Patients Following Postacute Rehabilitation. *J Gerontol A Biol Sci Med Sci*. 2017;72(2):223–8. [PubMed: 27492451]
11. Centers for Medicare & Medicaid Services. Chronic Condition Data Warehouse 1999–2016 [cited 2018 August 1]. Available from: URL: <https://www.ccwdata.org/web/guest/home>.
12. Intrator O, Hiris J, Berg K, Miller SC, Mor V. The Residential History File: Studying Nursing Home Residents' Long-Term Care Histories. *Health Serv Res* 2011;46(1 Pt 1):120–37. [PubMed: 21029090]
13. Rogers AT, Bai G, Lavin RA, Anderson GF. Higher Hospital Spending on Occupational Therapy is Associated with Lower Readmission Rates. *Med Care Res Rev* 2017;74(6):668–86. [PubMed: 27589987]
14. Kansagara D, Englander H, Salanitro A, et al. Risk Prediction Models for Hospital Readmission: A Systematic Review. *JAMA* 2011;306(15):1688–98. [PubMed: 22009101]
15. Graham JE, Prvu Bettger J, Middleton A, Spratt H, Sharma G, Ottenbacher KJ. Effects of Acute-Postacute Continuity on Community Discharge and 30-Day Rehospitalization Following Inpatient Rehabilitation. *Health Serv Res* 2017;52(5):1631–46. [PubMed: 28580725]
16. Wilmskoetter J, Simpson KN, Bonilha HS. Hospital Readmissions of Stroke Patients with Percutaneous Endoscopic Gastrostomy Feeding Tubes. *J Stroke Cerebrovasc Dis* 2016;25(10):2535–42. [PubMed: 27423366]
17. Vahidy FS, Donnelly JP, McCullough LD, Tyson JE, Miller CC, Boehme AK et al. Nationwide Estimates of 30-Day Readmission in Patients With Ischemic Stroke. *Stroke* 2017;48(5):1386–8. [PubMed: 28389607]
18. Bennett KJ, Probst JC. Thirty-Day Readmission Rates Among Dual-Eligible Beneficiaries. *J Rural Health* 2016;32(2):188–95. [PubMed: 26301454]
19. Strom JB, Kramer DB, Wang Y, Shen C, Wasfy JH, Landon BE et al. Short-Term Rehospitalization Across the Spectrum of Age and Insurance Types in the United States. *PLoS One* 2017;12(7):e0180767. [PubMed: 28700736]

Highlights:

- Higher intensity of rehabilitation care was associated with lower risk of 30-day hospital readmission
- Hospitals with rehabilitation unit were associated with lower risk of 30-day hospital readmission
- Hospitals need to integrate rehabilitation care to achieve better outcomes in value-based reimbursement environment

Figure 1.
The derivation of the cohort.

Table 1:

Patient- and hospital-level characteristics by readmission in patients with ischemic stroke.

N=88,826	Readmission 12,829 (14.44)	No Readmission 75,997 (85.56)	p-value
Patient Characteristics (%)			
Age (years)			
66–70	1,576 (12.28)	10,335 (13.60)	<.0001
71–75	2,070 (16.14)	13,026 (17.14)	
76–80	2,729 (21.27)	15,898 (20.92)	
81–85	3,137 (24.45)	17,785 (23.40)	
85+	3,317 (25.86)	18,953 (24.94)	
Female (male ref)	7,548 (58.84)	44,586 (58.67)	0.72
Race/Ethnicity			
White	10,332 (80.54)	63,168 (83.12)	<.0001
Black	1,548 (12.07)	7,690 (10.12)	
Other	949 (7.40)	5,139 (6.76)	
Dual Eligible (Medicare and Medicaid)	2,114 (16.48)	10,377 (13.65)	<.0001
Resident Zip Income Quartile (Low - High)			
1 (low)	2,284 (17.80)	12,557 (16.52)	0.0001
2	2,850 (22.22)	17,730 (23.30)	
3	3,226 (25.14)	19,738 (25.97)	
4 (high)	4,469 (34.84)	25,972 (34.18)	
Resident Zip Education Quartile (Low - High)			
1 (low)	2,375 (18.51)	12,740 (16.76)	<.0001
2	3,546 (27.64)	20,183 (26.56)	
3	3,850 (30.01)	23,695 (31.18)	
4 (high)	3,058 (23.84)	19,379 (25.50)	
Claim Based Severity Measure			
Number of Comorbid Conditions			
0	346 (2.70)	2,836 (3.73)	<.0001
1	2,030 (15.82)	15,684 (20.64)	
2	3,259 (25.40)	21,837 (28.73)	
3	7,194 (56.08)	35,640 (46.90)	
Prior Hospitalization in last 12 months	5,179 (40.37)	23,278 (30.63)	<.0001
Speech-language pathology (therapy categories)			
No	4,674 (36.43)	30,340 (39.92)	<.0001
Low	2,633 (20.52)	16,281 (21.42)	
Medium	2,975 (23.19)	17,733 (23.33)	
High	2,547 (19.85)	11,643 (15.32)	
Length of Stay Quintiles			
1–2 days	2,355 (18.36)	20,022 (26.35)	<.0001

N=88,826	Readmission 12,829 (14.44)	No Readmission 75,997 (85.56)	p-value
3 days	2,443 (19.04)	17,384 (22.87)	
4 days	1,949 (15.19)	12,224 (16.08)	
5–6 days	2,664 (20.77)	13,890 (18.28)	
>6 days	3,418 (26.64)	12,477 (16.42)	
Intensive Care Unit stay	6,859 (53.46)	37,394 (49.20)	<.0001
Feeding Tube	835 (6.51)	2,183 (2.87)	<.0001
Tissue plasminogen activator (tPA)	623 (4.86)	3,429 (4.56)	0.08
Rehabilitation Services			
Physical therapy categories			
No	1,666 (12.99)	10,677 (14.05)	<.0001
Low: 30 minutes during the stay	2,770 (21.59)	18,683 (24.58)	
Medium: >30 to 75 minutes	4,003 (31.20)	24,694 (32.49)	
High >75 minutes	4,390 (34.22)	21,943 (28.87)	
Occupational therapy categories			
No	4,378 (34.13)	26,615 (35.02)	<.0001
Low: 30 minutes during the stay	3,194 (24.90)	20,686 (27.22)	
Medium: >30 to 60 minutes	2,382 (18.57)	14,320 (18.84)	
High: >60 minutes	2,875 (22.41)	14,376 (18.92)	
Post-Acute discharge destination			
Home	3,343 (26.06)	25,883 (34.06)	<.0001
Home with Home Health	2,015 (15.71)	12,271 (16.15)	
Inpatient Rehabilitation Facility	3,162 (24.65)	17,993 (23.68)	
Skilled Nursing Facility (SNF)	4,309 (33.59)	19,850 (26.12)	
Hospital Characteristics			
Urban	11,489 (89.55)	66,912 (88.05)	<.0001
Profit Status	1706 (13.30)	9,576 (12.60)	0.02
Hospital with Inpatient Rehabilitation Unit	6,245 (48.68)	38,512 (50.68)	<.0001
Hospital with SNF Unit	420 (3.27)	2,766 (3.64)	0.03
Teaching Status			
Major	3,098 (24.15)	17,465 (22.98)	0.01
Limited	2,973 (23.17)	18,207 (23.96)	
No Affiliation	6,758 (52.68)	40,325 (53.06)	
Hospital Stroke Volume Quartile			
1 (123)	2,770 (21.59)	16,530 (21.75)	0.33
2 (124 – 228)	3,297 (25.70)	20,018 (26.34)	
3 (229 – 370)	3,317 (25.86)	19,472 (25.62)	
4 (371)	3,445 (26.85)	19,977 (26.29)	

Values are presented as mean $\pm$ standard deviation (SD) or %.

Household income and education were divided into quartiles based on the distribution of the sample (low: 1 to 4: high).

* Chi-square tests were used for categorical variables and t tests for continuous variables. The p-value was for a comparison between the readmission and non-readmission group.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2:

Patient and hospital characteristics associated with hospital readmission: results from multilevel model (patient nested within hospital).

Characteristics	Odds Ratio 95% CI
Rehabilitation Services	
Physical therapy categories	
No	Ref
Low: 30 minutes during the stay	0.90 (0.83 – 0.96)
Medium: >30 to 75 minutes	0.89 (0.82 – 0.95)
High: >75 minutes	0.86 (0.80 – 0.93)
Occupational therapy categories	
No	Ref
Low: 30 minutes during the stay	0.97 (0.91 – 1.02)
Medium: >30 to 60 minutes	0.98 (0.92 – 1.04)
High: >60 minutes	1.01 (0.95 – 1.08)
Patient characteristics	
Age (years)	
66–70	Ref
71–75	1.00 (0.93 – 1.08)
76–80	1.05 (0.98 – 1.13)
81–85	1.05 (0.98 – 1.12)
85+	1.02 (0.95 – 1.09)
Female (male ref)	1.08 (1.04 – 1.12)
Race/Ethnicity	
White	Ref
Black	1.05 (0.98 – 1.12)
Other	0.99 (0.91 – 1.07)
Dual Eligible (Medicare and Medicaid)	1.08 (1.02 – 1.15)
Resident Zip Income Quartile (Low - High)	
1 (low)	Ref
2	0.94 (0.88 – 1.01)
3	0.98 (0.91 – 1.04)
4 (High)	1.04 (0.97 – 1.12)
Resident Zip Education Quartile (Low - High)	
1 (low)	Ref
2	0.98 (0.92 – 1.04)
3	0.91 (0.85 – 0.98)
4 (high)	0.90 (0.83 – 0.97)
Claim Based Stroke Severity Measure	
Number of Comorbid Conditions	

Characteristics	Odds Ratio 95% CI
0	Ref
1	1.06 (0.93 – 1.19)
2	1.16 (1.03 – 1.31)
3	1.36 (1.20 – 1.53)
Prior Hospitalization in last 12 months	1.30 (1.24 – 1.36)
Length of Stay Quintiles	
1–2 days	Ref
3 days	1.09 (1.02 – 1.16)
4 days	1.21 (1.13 – 1.30)
5–6 days	1.41 (1.32 – 1.51)
>6 days	1.79 (1.67 – 1.93)
Intensive Care Unit Stay	1.09 (1.04 – 1.14)
Feeding Tube	1.53 (1.40 – 1.68)
Tissue plasminogen activator (tPA)	0.89 (0.81 – 0.98)
Speech-language pathology (therapy categories)	
No	Ref
Low	1.01 (0.96 – 1.07)
Medium	1.00 (0.95 – 1.06)
High	1.06 (1.00 – 1.13)
Post-Acute discharge destination	
Home	Ref
Home with Home Health	1.14 (1.07 – 1.21)
Inpatient Rehabilitation Facility	1.18 (1.16 – 1.25)
Skilled Nursing Facility	1.28 (1.20 – 1.35)
Hospital Characteristics	
Urban	1.11 (1.02 – 1.20)
Profit Status	1.04 (0.97 – 1.11)
Hospital with Inpatient Rehabilitation Unit	0.92 (0.88 – 0.96)
Hospital with swing beds	0.96 (0.85 – 1.08)
Teaching Status	
No Affiliation	Ref
Limited	0.95 (0.89 – 1.00)
Major	1.02 (0.96 – 1.08)
Hospital Volume (Low - High)	
1 (123)	Ref
2 (124 – 228)	0.95 (0.89 – 1.02)
3 (229 – 370)	0.98 (0.92 – 1.05)
4 (371)	0.98 (0.91 – 1.05)