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The effect of frailty on discharge location for Medicare beneficiaries after acute stroke

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Abstract

Objective: To examine the effect of frailty on post-stroke discharge location with respect to stroke severity and create a risk-adjusted model for understanding the effects of frailty on discharge to an inpatient rehabilitation facility.

Design: Retrospective cohort.

Setting: A 2014 5% Medicare Sample.

Participants: 7258 patients hospitalized for a first-time acute ischemic stroke.

Interventions: Not applicable.

Main Outcome Measures: A pre-hospitalization 6-month baseline was used to calculate a frailty score. Logistic regression to predict odds of discharge to inpatient rehabilitation was used to calculate for three levels of baseline frailty, controlling for patient demographics, stroke severity and co-morbidities.

Results: 1603 patients were discharged to inpatient rehabilitation. Patients who were non-frail (OR 1.716, 95%CI (1.463, 2.013) or pre-frail (OR 1.519, 95%CI (1.296, 1.779) were more likely to be discharged to inpatient rehabilitation. The final logistic regression model had a C-statistic of 0.63. The majority of patients discharged to inpatient rehabilitation were non-frail (44.2%) and had moderate strokes (38.9%). Individuals who were frail and suffered a moderate (OR 0.78, 95%CI (0.558, 1.091) or severe stroke (OR 0.509, 95%CI (0.358, 0.721) were less likely to be discharge to an inpatient rehabilitation facility.

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Conclusions: A lack of a claims-based measure for pre-stroke functional ability makes it difficult to understand discharge decision making patterns for individuals post-stroke. Pre-stroke frailty was found to have a significant effect on predicating inpatient rehabilitation discharge following an acute stroke when controlling for stroke severity, co-morbidities and age. Further investigation is warranted to examine differences in rehabilitation utilization based on frailty and to quantify the effect of rehabilitation on frailty status in individuals post-stroke.

Keywords

Frailty; Rehabilitation; Stroke

INTRODUCTION

Stroke continues to be a leading cause of disability in the United States with an estimated 610,000 first-time occurrences each year.[1] To reduce this disability burden many individuals post-stroke receive specialized rehabilitation services that aim to restore home and community independence.[2] The majority of post-stroke rehabilitation takes place outside of the acute hospital setting and is heavily influenced by the patient's discharge location (any location other than acute hospital care), which is associated with health and cost outcomes.[3, 4] In addition to the impact of discharge location on patient outcomes, often the decision-making process can cause stress for clinicians.[5] Therefore, it is imperative for clinicians to have evidence-based models for appropriately selecting a discharge location in order to optimize a patient's outcome.[5, 6] For example, observational, claims-based research findings indicate that individuals who receive rehabilitation at an inpatient rehabilitation facility (IRF) often have a greater level of functional recovery and reduced rates of rehospitalization compared to those discharged to a skilled nursing facility (SNF)[3, 4, 7]. In these studies, individuals discharged to IRFs have more prognostic factors for functional recovery.[3, 4, 7] However, despite increasing knowledge of prognostic factors for post-stroke recovery[8] there are still no accepted models for clinicians to use for determining an individual's likelihood to benefit from rehabilitation services.[9] A likely reason for this is confounding of stroke severity and pre-stroke functional ability that have been reported by clinicians as critical components of their decision[5] but are often not measurable using administrative data.[2, 10, 11] Thus, there is a need to develop comprehensive frameworks for assessing stroke severity and pre-stroke functional ability to understand the influence of these two constructs on determining discharge location.

A recent effort to address this need resulted in the development of a comprehensive index, the Stroke Administrative Severity Index (SASI), to quantify stroke severity at discharge.[12] The SASI has been validated against the National Institutes of Health (NIH) Stroke Severity Scale and has been thought to be an important variable for risk-adjustment in claims-based data for measuring post-discharge locations and outcomes.[12] To address the need for a pre-stroke functional ability construct, we propose using pre-admission frailty. The concept of frailty has gained interest due to its ability to explain an individual's level of independence better than age or accumulation of co-morbidities in the geriatric literature.[13] Theoretically, this make's sense given clinical measures of frailty typically include aspects of functional capacity (e.g. walking speed, grip strength, sit to stand capacity).[13, 14] Frailty's connection to independence makes it an appealing construct because it may provide a marker of functional ability for individuals at hospital admission.[15] Although there have been a few frailty scores for claims-based data[10, 16–18], in 2015, Faurot et. al. developed a frailty score (FS) based on the theoretical connection of frailty and function by defining frailty based on variables that predicted dependency for activities of daily living (ADL).[10]

Therefore, the purpose of this study is to examine the effect of frailty on post-stroke discharge location with respect to stroke severity to determine its usefulness as a marker of pre-stroke functional ability using claims-based data. Additionally, we plan to create a risk-adjusted model for understanding the effects of frailty on discharge to an inpatient rehabilitation facility for patients post stroke.

METHODS

Data Source:

We constructed a retrospective cohort of adults hospitalized for a first-time ischemic stroke from a 5% US national sample of the Medicare Limited dataset (LDS) for 2014 using Medicare fee-for-service patient claim data. Patients were included if they had Medicare coverage and claim data for a minimum of 6-months prior to their hospitalization. We extracted all claims for inpatient, outpatient, nursing home, and hospice services as well as durable medical equipment. All inpatient hospitalization records were used to construct a Charlson score[19] and SASI score[12] for each individual patient using previously published methods. Age was treated as a continuous variable. Dual eligibility was determined at time of hospitalization for the acute stroke. Medicare state codes were used to group patients into the census-defined regions of the United States. Discharge location was determined from the initial stroke admission record. Patients were included if they were discharged to home without rehabilitation, home with home health rehabilitation, a skilled nursing facility (SNF) or an inpatient rehabilitation facility (IRF). Patients were excluded if they died during their hospitalization, left against medical advice, there was not discharge location available or they were not discharged to a post-acute facility that placed an emphasis on rehabilitation for returning to home including hospice, long-term acute care hospitals or correctional facilities.

Frailty Measure

We used the Faurot Frailty Index to calculate a frailty score for each patient using claim data from inpatient, outpatient and durable medical equipment records during a 6-month period prior to each participant's hospitalization. The Faurot Frailty Index is a linear model that predicts ADL dependence based on responses from the 2006 Medicare Current Beneficiary Survey. The model contains groups of ICD-9, CPT and HCPC codes that are theoretically associated or congruent with frailty.[10] Therefore, the model is able to capture other ADL dependent constructs in addition to disease accumulation. Protective variables against frailty such as cancer screening and rehabilitation service use are maintained in the model. The full model and included codes can be found in the published appendix to Faurot et. al., 2015.[10]

Patients were then classified into three categories Non-frail (Robust), Pre-Frail and Frail using the sample's Faurot Frailty Index tertial cut-points (Non-frail; score<0.1. Pre-frail;

score 0.1–4.9 Frail; score >5.0). Transforming an index value to a categorical score has been shown to improve the comparability of different frailty measures in previous studies may provide a more interpretable outcome for clinical utility.[20–22]

Statistical Analysis

SAS software version 9.4 (SAS Institute Inc., Cary, NC) was used for the analysis. Descriptive statistics were used to compare groups defined by frailty for both the initial and inpatient rehabilitation cohort. Group comparisons were conducted using a chi-square test for categorical variables and a t-test for continuous variables. P-values were not reported below a 0.05 level given that large samples often result in statistically significant differences even when there may not be clinical relevance to the finding. Logistic regression model fitting was used to evaluate the impact of frailty on IRF discharge using forward progression. Variables were entered in the following order: stroke severity (SASI score), co-morbidities (Charlson score), age, sex, dual eligibility (Medicare and Medicaid), and African-American race. Race was coded as African-American and non-African-American (Caucasian and all other races) given the low proportions of races other than Caucasian and African-American in our sample. Non-significant variables remained in the model to present the most comprehensive picture of individuals discharged to an IRF and maintain representation of conceptual variables described by clinicians when making discharge decisions. A second model was created replicating this methodology using patients classified as non-frail and pre-frail to report on the effect of frailty between these two groups. Finally, an exploratory analysis on the interaction between stroke severity and frailty was examined using model 1. Interaction terms were considered significant if $p<0.10$. The effects of significant interactions were quantified with adjusted odds ratios using logistic regression.

RESULTS

A total of 7258 acute stroke hospital admissions were included in the analysis. The overall demographics of the sample are presented in Table 1. Our sample is primarily older (mean age 79.4 years), Caucasian (83.9%), suffered a mild stroke (45%) and spent an average of 5.4 days in the hospital for their acute admission. Table 1 also presents the demographic data of our sample grouped by frailty categories. There was a significant difference in age between the three groups with the oldest patients in the frail group (mean age 82 years). There were significantly more females in the pre-frail group (21.1%) than the frail or non-frail group. Additionally, there was a higher percentage of patients who met the requirements for dual eligibility in the frail group (27.0%) compared to both the pre-frail and non-frail groups. Frail patients also spent more days on average (mean LOS 5.9 days, SD 4.2 days) in the hospital than the pre-and non-frail individuals.

A greater percentage of non-frail patients were discharged to an IRF (25.0%) compared to pre-frail (22.3%) and frail individuals (17.2%). Additionally, a higher percentage of frail individuals were discharged to a SNF (46.9%) than non-frail (18.5%) and pre-frail patients (28.0%). There was a lower percentage of frail patients discharged home (14.0%) without rehabilitation compared to non- (38.7%) and pre-frail individuals (29.7%).

From the overall sample, 1603 patients were discharged to an IRF. Table 2 displays the demographic data for this subset of patients. This subset consisted of individuals who were older (mean age 78.4 years), Caucasian (82.5%) and spent an average of 5.7 days in the hospital. The sample was relatively equal in male and female sex (56.6% female) and had a low percentage of dual eligible patients (14.8%). Most patients discharged to an IRF were non-frail (44.2%) and suffered a moderate stroke (39.8%) based on SASI score.

In Table 2, the IRF subset of patients' demographic data is presented by frailty category. There was a significant difference in age between the non-frail (mean years 76.7, SD 8) patients and both the pre-frail (mean years 79.6, SD 8) and frail individuals (mean years 80.4, SD 7.7). There was also a significant difference in Charlson score between the frail (mean 2.2, SD 1.9) and both the pre-frail (mean 1.8, SD 1.7) and non-frail groups (mean 1.9, SD 1.7). A significant difference in dual eligibility patients existed between the pre-frail (12.7) and frail (18%) groups with more individuals meeting the criteria in the frail group. Mean days for length of stay, hospital charge and hospital payments were similar across all groups.

Odd ratios from logistic regression model fitting are presented in Table 3 with a 95% confidence interval for the frailty categories as it relates to an IRF discharge location. Both models include all variables of interest and have C-statistics of 0.63 and 0.64 respectively. When controlling for stroke severity, co-morbidities and demographic characteristics, non-frail patients had a 71% higher chance of being discharged to an IRF compared to frail patients (OR 1.716, 95%CI (1.463, 2.013)) and pre-frail patients were 52% more likely to be discharged to an IRF than frail patients (OR 1.519, 95%CI (1.296, 1.779)). In addition to frailty, patients were more likely to be discharged to an IRF if they had a more severe stroke, more co-morbid conditions, and younger. Of note, patients were 25% less likely to be discharged to an IRF if they were dual eligible (OR 0.738, 95%CI (0.628, 0.868)) and 31% more likely to be discharged to an IRF if they were of African-American race (OR 1.305, 95%CI (1.092, 1.559)).

A significant interaction was found between stroke severity and frailty ($p<0.0001$) during our exploratory interaction analysis using model 1. Individuals who had moderate (OR 1.974, 95%CI (1.726, 2.258)) and severe strokes (OR 2.276, 95%CI (1.955, 2.649)) were more likely to be discharged to an IRF. However, if individuals were frail and suffered a moderate stroke they were 22% (OR 0.78, 95%CI (0.558, 1.091) less likely to be discharged to an IRF and 50% (OR 0.509, 95%CI (0.358, 0.721) less likely if they had suffered a severe stroke. The demographics of these two subgroups of patients are presented in Table 4.

DISCUSSION

We created a retrospective cohort of individuals who were hospitalized for an ischemic stroke to determine the impact of frailty on discharge location using administrative, claims-based Medicare records. We found that a greater percentage of frail individuals were discharged to a SNF, rather than an IRF or home without rehabilitation than individuals who were categorized as non- or pre-frail. A similar finding holds true for pre-frail individuals, with a higher percentage discharged to a SNF and lower percentage to an IRF or home without rehabilitation than non-frail individuals. This relationship appears to support the use of frailty as a measure of pre-stroke functional ability. Specifically, it aligns with the idea that clinicians attempt to assign patients to rehabilitation location that promotes a return to their previous level of independence.

For individuals discharged to an IRF, we found the majority had suffered a moderate stroke and were classified as non-frail. We also found frailty was the strongest determinant for whether an individual would be discharged to an IRF following an acute ischemic stroke with non-frail individuals having the highest odds, followed by pre-frail individuals. Additionally, we did find a significant interaction term between frailty and stroke severity. Exploratory analysis of this interaction found that patients who suffered a severe stroke that were frail were about 50% less likely to go to an IRF. If frailty was removed from the model, then a severe stroke increased an individual’s chance over two and a half fold. The fact that frailty increased the odd of an inpatient rehabilitation discharge for patients with a severe stroke suggests that clinicians may be prioritizing an individual’s prior level of function over stroke severity when making a discharge decision.[8, 23] With recent evidence and recommendations supporting the use of physical activity and exercise to prevent or reverse frailty[24–26] it could be argued that clinicians may need to place more emphasis on discharging frailer individuals into intensive rehabilitation programs to enhance independence and functional outcomes.

To our knowledge, this is only the second study to operationalize a claims-based measure for pre-stroke functional ability. In 2016, Kumar et. al.[11] tested the Functional Comorbidity Index (FCI)’s ability to explain differences in measures of mobility, self-care and motor functional status from the Functional Independence Measure (FIM) on admission to an IRF for individuals post-stroke. The FCI was developed by Groll et. al.[27] to measure physical function. However, even with the presence of multiple co-morbidity indices, the FCI did not significantly add to the base model consisting of patient demographics. The same group also found that the FCI did not increase the strength of their regression model when attempting to predict community discharge from an IRF in comparison to a base model with patients discharge FIM scores.[28] Our results are contradictive to these, likely due to methodological differences in our operationalization of pre-stroke functional ability. First, we used a 6-month baseline period to calculate our frailty score prior to the patient’s acute hospitalization. Calculating a measure of function prior to hospitalization should provide a more accurate picture of an individual’s pre-stroke level of independence and remove the confounding effect of impairments incurred by the stroke itself. Second, we controlled for stroke severity in our predictive models. By controlling for stroke severity, we can account for impairments the patient obtained secondary to stroke provided severity is correlated with physical abilities post-stroke. In addition to our methodological differences, frailty is likely a more accurate measure for the stroke population compared to the FCI for measuring pre-stroke functional ability. For example, a limitation of the FCI is that the measure was validated among community dwelling young and middle-age adults[27, 28], while frailty is often associated with aging and can capture the physical decline of individuals who suffer a stroke given their older ages.

In addition, we found that patients of African-American race were 30% more likely to be discharged to an IRF. We are unable to identify a cause for this difference; however, this finding aligns with previous reports. A review by Ellis et al.[29] found that African-American patients in the United States were more likely than Caucasian or Hispanic patients to receive physical therapy and occupational therapy post-stroke as well as be referred to outpatient rehabilitation after discharge. Our findings add to emerging evidence that there are racial and ethnic difference in rehabilitation utilization. There is a need for future studies to examine other factors that may result in these types of disparities such as healthcare philosophies related to rehabilitation practices, regional differences and community characteristics.[29–31]

Future work should to be done to establish the validity of frailty as a marker of functional ability. Similar to Kumar et. al.[11], frailty scores could be calculated at discharge from acute hospitalization and compared to various sub-scores of the FIM that are taken during admission to an IRF. Additionally, retrospective claim data frailty scores could be validated using clinical measures of frailty either prospectively or from electronic health record data during a pre-hospitalization period. If frailty can serve as a marker of functional ability, the next logical step would be to examine the effect of rehabilitation on frailty status.

Study Limitations

This study has important limitations. First, our results are only generalizable to the Medicare population. Next, we assumed that all the reported claim data for each patient was accurate. Unfortunately, there is the possibility that claims were not reported, over-reported or underreported without our knowledge creating a potential source of bias that underlies Medicare claim data research. Similarly, there is an inherent risk of potential misclassification of patients due to errors in ICD-9 and billing code reporting. Calculating frailty from a baseline period is more sensitive to this limitation as individuals may have received durable medical equipment prior to our measured period and still be using it. However, this does cause a bias towards classifying individuals as pre- or non-frail, making it more difficult to find differences. Finally, we did not have inpatient rehabilitation functional assessment data to link to our frailty or SASI scores to determine if our model was accurately controlling for a patient’s level of independence.

CONCLUSION

Medicare patients who are frail before they have an acute ischemic stroke are less likely to receive inpatient rehabilitation after stroke, compared no non-frail patients with similar stroke severity. This study is the first attempt to examine discharge destination patterns among individuals post-stroke when controlling for stroke severity, co-morbidities and a measure of pre-stroke functional ability. Our results suggest that frailty may serve as an acceptable proxy for pre-stroke functional ability and can be used to examine variations in rehabilitation utilization. Future research should examine the strength of frailty as a measure of functional status and the ability of rehabilitation services to change frailty status.

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Abbreviations:

SASI	Stroke Administrative Severity Index
IRF	Inpatient Rehabilitation Facility
SNF	Skilled Nursing Facility
FCI	Functional Comorbidity Index

References:

1. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R et al. Heart Disease and Stroke Statistics—2017 Update: A Report From the American Heart Association. Circulation 2017;135(10):e146. [PubMed: 28122885]
2. Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC et al. Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2016;47(6):e98–e169. [PubMed: 27145936]
3. Deutsch A, Granger CV, Heinemann AW, Fiedler RC, DeJong G, Kane RL et al. Poststroke rehabilitation: outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs. Stroke 2006;37(6):1477–82. [PubMed: 16627797]
4. Kramer AM, Steiner JF, Schlenker RE, Eilertsen TB, Hrincevich CA, Tropea DA et al. Outcomes and costs after hip fracture and stroke. A comparison of rehabilitation settings. Jama 1997;277(5): 396–404. [PubMed: 9010172]
5. Luker JA, Bernhardt J, Grimmer KA, Edwards I. A qualitative exploration of discharge destination as an outcome or a driver of acute stroke care. BMC health services research 2014;14:193. [PubMed: 24774583]
6. Enderby P, Pandyan A, Bowen A, Hearnden D, Ashburn A, Conroy P et al. Accessing rehabilitation after stroke - a guessing game? Disability and rehabilitation 2017;39(7):709–13. [PubMed: 27133783]
7. Kane RL, Chen Q, Finch M, Blewett L, Burns R, Moskowitz M. Functional outcomes of posthospital care for stroke and hip fracture patients under medicare. Journal of the American Geriatrics Society 1998;46(12):1525–33. [PubMed: 9848813]
8. Hakkennes SJ, Brock K, Hill KD. Selection for inpatient rehabilitation after acute stroke: a systematic review of the literature. Archives of physical medicine and rehabilitation 2011;92(12): 2057–70. [PubMed: 22133256]
9. Wade DT. Selection criteria for rehabilitation services. Clinical rehabilitation 2003;17(2):115–8. [PubMed: 12625650]
10. Faurot KR, Jonsson Funk M, Pate V, Brookhart MA, Patrick A, Hanson LC et al. Using claims data to predict dependency in activities of daily living as a proxy for frailty. Pharmacoepidemiol Drug Saf 2015;24(1):59–66. [PubMed: 25335470]
11. Kumar A, Graham JE, Resnik L, Karmarkar AM, Tan A, Deutsch A et al. Comparing comorbidity indices to predict post-acute rehabilitation outcomes in older adults. American Journal of Physical Medicine and Rehabilitation 2016;95(12):889–98. [PubMed: 27149597]

12. Simpson AN, Wilmskoetter J, Hong I, Li CY, Jauch EC, Bonilha HS et al. Stroke Administrative Severity Index: using administrative data for 30-day poststroke outcomes prediction. Journal of comparative effectiveness research 2018;7(4):293–304. [PubMed: 29057660]
13. Dent E, Kowal P, Hoogendijk EO. Frailty measurement in research and clinical practice: A review. European journal of internal medicine 2016;31:3–10. [PubMed: 27039014]
14. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J et al. Frailty in older adults: evidence for a phenotype. The journals of gerontology Series A, Biological sciences and medical sciences 2001;56(3):M146–56.
15. Hubbard RE, Peel NM, Samanta M, Gray LC, Mitnitski A, Rockwood K. Frailty status at admission to hospital predicts multiple adverse outcomes. Age and ageing 2017:1–6.
16. Davidoff AJ, Zuckerman IH, Pandya N, Hendrick F, Ke X, Hurria A et al. A novel approach to improve health status measurement in observational claims-based studies of cancer treatment and outcomes. J Geriatr Oncol 2013;4(2):157–65. [PubMed: 23795223]
17. Segal JB, Chang HY, Du Y, J DW, M CC, Varadhan R. Development of a Claims-based Frailty Indicator Anchored to a Well-established Frailty Phenotype. Medical care 2017;55(7):716–22. [PubMed: 28437320]
18. Kim DH, Schneeweiss S, Glynn RJ, Lipsitz LA, Rockwood K, Avorn J. Measuring Frailty in Medicare Data: Development and Validation of a Claims-Based Frailty Index. The journals of gerontology Series A, Biological sciences and medical sciences 2018;73(7):980–7.
19. Quan H, Li B, Couris CM, Fushimi K, Graham P, Hider P et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. American journal of epidemiology 2011;173(6):676–82. [PubMed: 21330339]
20. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. The journals of gerontology Series A, Biological sciences and medical sciences 2007;62(7):722–7.
21. Rockwood K, Andrew M, Mitnitski A. A Comparison of Two Approaches to Measuring Frailty in Elderly People. The Journals of Gerontology: Series A 2007;62(7):738–43.
22. Rockwood K, Mitnitski A, Song X, Steen B, Skoog I. Long-Term Risks of Death and Institutionalization of Elderly People in Relation to Deficit Accumulation at Age 70. Journal of the American Geriatrics Society 2006;54(6):975–9. [PubMed: 16776795]
23. Hakkennes S, Hill KD, Brock K, Bernhardt J, Churilov L. Selection for inpatient rehabilitation after severe stroke: what factors influence rehabilitation assessor decision-making? Journal of rehabilitation medicine 2013;45(1):24–31. [PubMed: 23096140]
24. Chou CH, Hwang CL, Wu YT. Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: a meta-analysis. Archives of physical medicine and rehabilitation 2012;93(2):237–44. [PubMed: 22289232]
25. Marzetti E, Calvani R, Tosato M, Cesari M, Di Bari M, Cherubini A et al. Physical activity and exercise as countermeasures to physical frailty and sarcopenia. Aging Clin Exp Res 2017;29(1):35–42.
26. de Labra C, Guimaraes-Pinheiro C, Maseda A, Lorenzo T, Millan-Calenti JC. Effects of physical exercise interventions in frail older adults: a systematic review of randomized controlled trials. BMC geriatrics 2015;15:154. [PubMed: 26626157]
27. Groll DL, To T, Bombardier C, Wright JG. The development of a comorbidity index with physical function as the outcome. Journal of clinical epidemiology 2005;58(6):595–602. [PubMed: 15878473]
28. 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. Physical therapy 2016;96(2):232–40. [PubMed: 26564253]
29. Ellis C, Egede LE. Racial/ethnic differences in poststroke rehabilitation utilization in the USA. Expert review of cardiovascular therapy 2009;7(4):405–10. [PubMed: 19379064]
30. Jacobs BS, Birbeck G, Mullard AJ, Hickenbottom S, Kothari R, Roberts S et al. Quality of hospital care in African American and white patients with ischemic stroke and TIA. Neurology 2006;66(6):809–14. [PubMed: 16567696]

31. Institute of Medicine Roundtable on Environmental Health Sciences R, Medicine. Rebuilding the Unity of Health and the Environment in Rural America: Workshop Summary. Washington (DC): National Academies Press (US); 2006.

Highlights

- Frailty was a significant predictor of discharge location post-stroke
- More frail patients were discharged to skilled nursing facilities.
- Non-frail patients were 71% more likely to be discharged to inpatient rehabilitation

Table 1:

Description of Medicare beneficiaries with ischemic stroke characteristics (presented as a group and subdivided by frailty category)

	All patients with ischemic stroke n = 7258	Non-Frail n=2835 (39.1%)	Pre-Frail n=2616 (36.0%)	Frail n=1807 (24.9%)
Age (years) mean (SD) [range]	79.4 (8.4) [63–98]	78.0 (8.3) *† [63–98]	80.1 (8.2)‡ [64–98]	82.0 (7.9) [64–98]
Female N (%)	56.7%	50.2% *†	58.7%‡	64.3%
Race (%): Caucasian	83.9%	82.6%	85.4%	83.9%
African-American	10.8%	11.2%	10.0%	11.3%
Hispanic	1.5%	1.3%	1.5%	2.1%
Other	3.8%	4.9%	3.2%	2.6%
Dual Eligibility (%)	17.3%	12.4% *†	16.0%‡	27.0%
Charlson Score mean (SD) [range]	1.6 (1.8) [0–13]	1.3 (1.6) *† [0–13]	1.5 (1.8) [0–11]	2.2 (1.9) [0–13]
Stroke Severity (SASI Category) (%):				
Mild	45.0%	46.9%	47.3%‡	38.9%
Moderate	32.9%	34.8% *†	32.3%‡	30.7%
Severe	22.1%	18.3%	20.4%	30.4%
LOS (days) mean (SD) [range]	5.4 (4.4) [1–116]	5.2 (5.0)† [1–116]	5.3 (3.9)‡ [1–41]	5.9 (4.2)‡ [1–71]
Total Hospital Charge ($) mean (SD) [range]	$40,523 ($42,686) [$1,494 -$836,706]	$40,245 ($43,870) [$1,494-$632,949]	$39,312 ($38,746)‡ [$1,867-$498,402]	$42,710 ($46,054) [$2,656-$836,706]
Total Hospital Payment ($) mean (SD) [range]	$8,005 ($7,696) [$0-$162,728]	$7,675 ($8,288)† [$0-$142,825]	$7,832 ($6,869)‡ [$0-$135,569]	$8,771 ($7,816) [$0-$162,728]
Geographic Distribution (%):				
Northeast	18.77%	17.99%	18.77%	19.98%
Midwest	24.95%	25.26%†	26.49%‡	22.25%
South	39.98%	40.21%	38.95%	41.12%
West	15.82%	15.84%	15.41%	16.38%
Other	0.48%	0.71%	0.38%	0.28%
Discharge to inpatient rehab (%)	22.0%	25.0% *†	22.3%‡	17.2%
Discharge to skilled nursing facility (%)	29.0%	18.5% *†	28.0%‡	46.9%
Discharge to home health (%)	14.1%	13.0% *	15.1%	14.5%
Discharged to home, no rehab (%)	29.3%	38.7% *†	29.7%‡	14.0%

* Indicates a significant difference (p<0.05) between non-frail and pre-frail patients

† Indicates a significant difference ($p<0.05$) between non-frail and frail patients

‡ Indicates a significant difference ($p<0.05$) between pre-frail and frail patients

Table 2:

Description of Medicare beneficiaries with ischemic stroke discharged to an inpatient rehabilitation facility (IRF) characteristics (presented as a group and subdivided by frailty category)

	All patients discharged to an IRF n = 1603	Non-Frail n=709 (44.2%)	Pre-Frail n=584 (36.4%)	Frail n=310 (19.3%)
Age (years) mean (SD) [range]	78.4 (8.1) [64–98]	76.7 (8.0) *† [64–98]	79.6 (8.0) [64–98]	80.4 (7.7) [64–98]
Female (%)	56.6%	51.8% *†	59.4%	62.6%
Race (%): Caucasian	82.5%	79.7%	83.9%	86.5%
African-American	12.7%	14.1%	12.0%	10.7%
Hispanic	1.0%	1.0%	1.4%	0.3%
Other	3.8%	5.2%	2.7%	2.6%
Dual Eligibility (%)	14.8%	12.7% †	15.6%	18.0%
Charlson Score mean (SD) [range]	1.8 (1.7) [0–11]	1.8 (1.7) † [0–11]	1.9 (1.7) ‡ [0–11]	2.2 (1.9) [0–9]
Stroke Severity (SASI Category) (%):				
Mild	31.1%	28.5%	34.6%	30.3%
Moderate	39.8%	42.3%	38.2%	37.1%
Severe	29.1%	29.2%	27.2%	32.6%
LOS (days) mean (SD) [range]	5.7 (3.6) [1–50]	5.8 (3.7) [1–50]	5.6 (3.4) [2–34]	5.9 (3.7) [1–33]
Total Hospital Charge ($) mean (SD) [range]	$47,278 ($45,633) [$4,074- $632,949]	$4,8082 ($5,0985) [$5,285 -$632,949]	$45,922 ($41,710) [$4,074-$422,902]	$47,994 ($39,399) [$5,289 -$244,411]
Total Hospital Payment ($) mean (SD) [range]	$8,419 ($7,519) [$0-$142,825]	$8,348 ($9,033) [$0-$142,825]	$8,343 ($6,323) [$0-$70251]	$8,724 ($5,532) [$0-$39,270]
Geographic Distribution (%):				
Northeast	21.52%	20.17%	21.40%	24.84%
Midwest	23.14%	23.84%	23.29%	21.29%
South	40.86%	41.33%	40.75%	40.00%
West	14.41%	14.53%	14.55%	13.87%
Other	0.06%	0.14%	0.00%	0.00%

[*] Indicates a significant difference ($p<0.05$) between non-frail and pre-frail patients

[†] Indicates a significant difference ($p<0.05$) between non-frail and frail patients

[‡] Indicates a significant difference ($p<0.05$) between pre-frail and frail patients

Table 3:

Results of logistic model fitting for explaining inpatient rehabilitation facility discharge following an acute stroke hospitalization

Variables	Non-Frail vs Frail	Pre-Frail vs Frail	SASI Score	Charlson Score	Age	Female	Dual Eligible	African-American	C-statistic
Model 1									
OR (95% CI)	1.716 (1.463, 2.013)	1.519 (1.296, 1.779)	1.529 (1.420, 1.647)	1.082 (1.048, 1.117)	0.986 (0.979, 0.993)	1.041 (0.926, 1.170)	0.738 (0.628, 0.868)	1.305 (1.092, 1.559)	0.63
Variables	**Non-Frail vs Pre-Frail**	**SASI Score**	**Charlson Score**	**Age**	**Female**	**Dual Eligible**	**African-American**		**C-statistic**
Model 2									
OR (95% CI)	1.161 (1.019, 1.324)	1.626 (1.494, 1.770)	1.105 (1.065, 1.147)	0.990 (0.982, 0.998)	1.050 (0.921, 1.198)	0.857 (0.710, 1.034)	1.388 (1.136, 1.695)		0.64

Table 4:

Description of Frail Medicare beneficiaries with moderate and severe strokes

	Moderate Stroke **n = 554**	**Severe Stroke** **n=550**
Age (years) mean (SD) [range]	81.7 (8.1) [64–98]	81.8 (7.9) [64–98]
Female N (%)	62.1% *	71.09%
Race (%): Caucasian	79.8% *	85.5%
African-American	13.9% *	9.8%
Hispanic	2.7%	2.9%
Other	3.6%	1.8%
Dual Eligibility (%)	28.2%	28.7%
Charlson Score mean (SD) [range]	2.3 (1.9) * [0–11]	2.6 (1.9) [0–13]
LOS (days) mean (SD) [range]	6.1 (4.0) * [1–34]	6.6 (4.4) [1–13]
Total Hospital Charge ($) mean (SD) [range]	$44,784 ($45,271.85) [$3,652-$356,939]	$47,847 ($47,867) [$4,350-$467,125]
Total Hospital Payment ($) mean (SD) [range]	$9,175 ($7,718) [$0-$123,780]	$9,236 ($7,241) [$0-$89,418]
Geographic Distribution (%):		
Northeast	22.74%	19.45%
Midwest	19.49%	22.00%
South	40.97%	39.82%
West	16.61%	18.55%
Other	0.18%	0.18%
Discharge to inpatient rehab (%)	20.8%	18.4%
Discharge to skilled nursing facility (%)	44.8% *	53.3%
Discharge to home health (%)	15.9% *	11.6%
Discharged to home, no rehab (%)	25.5%	20.9%

*Indicates a significant difference (p<0.05) between frail patients with a severe or moderate stroke