Physical and Occupational Therapy From the Acute to Community Setting After Stroke: Predictors of Use, Continuity of Care, and Timeliness of Care

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Abstract

Objective: To identify predictors of therapist use (any use, continuity of care, timing of care) in the acute care hospital and community (home or outpatient) for patients discharged home after stroke.

Design: Retrospective cohort analysis of Medicare claims (2010−2013) linked to hospital-level and county-level data.

Setting: Acute care hospital and community.

Participants: Patients (N = 23,413) who survived the first 30 days at home after being discharged from an acute care hospital after stroke.

Interventions: Not applicable.

Main Outcome Measures: Physical and occupational therapist use in acute care and community settings; continuity of care across the inpatient and home or the inpatient and outpatient settings; and early therapist use in the home or outpatient setting. Multivariate logistic and multinomial logistic regression analyses were conducted to identify hospital-level, county-level, and sociodemographic characteristics associated with therapist use, continuity, and timing, controlling for clinical characteristics.

Results: Seventy-eight percent of patients received therapy in the acute care hospital, but only 40.8% received care in the first 30 days after discharge. Hospital nurse staffing was positively associated with inpatient and outpatient therapist use and continuity of care across settings. Primary care provider supply was associated with inpatient and outpatient therapist use, continuity of care, and early therapist care in the home and outpatient setting. Therapist supply was associated with continuity of care and early therapist use in the community. There was consistent evidence of sociodemographic disparities in therapist use.

Conclusions: Therapist use after stroke varies in the community and for specific sociodemographic subgroups and may be underused. Inpatient nurse staffing levels and primary care provider supply were the most consistent predictors of therapist use, continuity of care, and early therapist use.
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Approximately 80% to 90% of stroke survivors have residual movement impairment after stroke[1-3] and are vulnerable to inactivity, falls, and hospital readmission.[4-8] Physical and occupational therapists play a key role in the rehabilitation of stroke survivors with movement impairments.[1,2] Data suggest that early contact with a therapist and more intense therapy (eg, greater number of visits per time) may promote better recovery after stroke[9-12] and may decrease the risk of hospital readmission, falls, and other adverse health care events.[13-15]

While clinical practice guidelines recommend rehabilitation evaluation and treatment as soon as possible after hospital

admission for stroke,[11,16-18] short lengths of acute care stays shift most of the therapist care to postacute settings. Stroke survivors with more severe limitations, a lack of family support, or both, are more likely to be discharged to a postacute inpatient setting (eg, inpatient rehabilitation facility or skilled nursing facility), but most (~60%) are discharged directly home.[19,20] Understanding the care pathway from the acute to community setting and the continuity of therapist care across settings has implications for determining whether patients are receiving appropriate and timely care; for delivering care via models that promote care coordination (eg, accountable care organizations, patient-centered medical homes) and team-based care; and for developing payment models that are bundled or episode based. Appropriate use of therapists in the acute and postacute community setting and continuity of care across settings maximize patient outcomes and may be effective in minimizing downstream health care costs.[13,14]

We aimed to describe the use of physical therapists and occupational therapists in the acute and postacute community settings (ie, home and/or outpatient setting) for patients who are discharged home after stroke, and to identify predictors of therapist use, continuity of therapist care across settings, and timing of therapist use in these settings. We were particularly interested in describing the extent to which contextual factors, at both the hospital and community level, explained variation in therapist use, as these factors may be mutable through intervention or policy changes. We also assessed sociodemographic variation in therapist use.

Methods

Conceptual model

Our conceptual model, derived from the literature on health care use and quality, illustrates that both clinical and nonclinical factors influence therapist use in the acute and postacute community settings (fig 1). We hypothesized that clinical factors (eg, stroke severity, comorbidities) or measures of "need" have the largest impact on therapist use, but sociodemographic factors (eg, race, insurance) also affect use.[20] We also hypothesized that hospital characteristics such as patient volume and medical school affiliation were proxies for quality of care[21-26] and would influence whether the patient received care from a therapist. Finally, we hypothesized that characteristics of the county (eg, provider supply) where the patient lived would be associated with therapist use.

Data sources

Our primary data source was a 20% random sample of Medicare claims (2010–2013) merged with data from the American Hospital Association database, the Centers for Medicare and Medicaid Services Provider of Services files, and the Area Health Resource file to obtain information on hospital characteristics where the patients were treated and health care supply and socioeconomic factors in the county where the stroke survivor resided.

List of abbreviations:

PCP primary care physician
PMR physical medicine and rehabilitation
RN registered nurse

Study design and cohort

We used a retrospective cohort design to identify Medicare beneficiaries admitted to short-term acute care hospitals for stroke between 2010 and 2013. We established a 6-month baseline period before the admission to assess comorbidities and health care use; the hospitalization period to assess comorbidities and clinical characteristics, as well as therapist use; and a 30-day period after discharge home to assess the use and timing of in-home and outpatient therapy (fig 2). We limited our sample to Medicare beneficiaries who (1) were aged ≥66 years at admission (to ensure that cases were Medicare eligible during the 6-mo baseline period); (2) survived the hospital stay and were discharged home; (3) remained at home and survived the first 30 days after discharge; and (4) were continuously enrolled in Medicare Parts A and B. We excluded individuals hospitalized for stroke during the 6-month baseline period and individuals with a diagnosis of transient ischemic attack. We identified stroke based on primary and secondary *International Classification of Diseases, Ninth Revision, Clinical Modification* discharge diagnoses codes (supplemental table S1, available online only at http://www.archives-pmr.org/).[27-31]

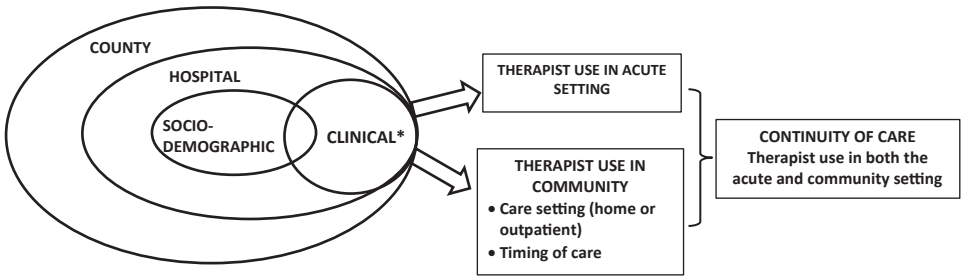
Explanatory and outcome variables

Explanatory variables included clinical characteristics (characteristics of the hospitalization and comorbidities, baseline comorbidities, baseline health care use); sociodemographic characteristics (age, race, dual eligibility, income); hospital structural, organizational, human resource, and geographic characteristics (ownership, accreditation, medical school affiliation, Medicare and Medicaid discharges, bed size, registered nurse [RN] full-time equivalents per admission, metropolitan location); and county-level characteristics where the patient lived (per capita primary care physician [PCP] supply, physical therapist supply, neurologist supply, physical medicine and rehabilitation [PMR] physician supply, metropolitan status).

We identified therapist use based on revenue center codes and Healthcare Common Procedure Coding System/Current Procedural Terminology codes for therapy-related procedures.[32] We created a dichotomous variable to indicate whether the patient received inpatient therapist care (yes, no), and 3 categorical variables to indicate whether the patient received postacute therapist care (in home, outpatient, no care), continuity of care (therapist care in the hospital and at home; therapist care in the hospital and outpatient setting; no continuity of care, defined as therapist care in hospital only), and early therapist care if the visit occurred below the median days to first visit (early care in home, early care in outpatient setting, later care). Explanatory and outcome variables are defined in detail in supplemental tables S2 through S4 (available online only at http://www.archives-pmr.org/).

Analysis

We first conducted descriptive analyses to identify therapist use in the inpatient, home, and outpatient settings. We then conducted multivariate logistic and multinomial logistic regression analyses to identify predictors of acute and postacute therapist use, continuity of care across the acute and community setting, and early postacute therapist use. All analyses were conducted in Stata version 14[a] using the robust SE option and clustering on hospital.



*the intersection of sociodemographic and clinical factors reflects the fact that it is sometimes difficult to disentangle sociodemographic factors (e.g., age) from need factors

Fig 1 Conceptual model.

Sensitivity analyses

We limited our analyses to the following subgroups to assess the extent to which our findings changed for patients who may have had a greater need for therapy: (1) patients with a primary discharge diagnosis of stroke; (2) patients with baseline or hospitalization comorbidities indicative of movement problems or frailty[33] (ie, aphasia, movement abnormalities, hemiparesis, falls, paralysis, renal failure, incontinence, neurologic problems, Parkinson disease, use of oxygen, use of a wheelchair, vertigo, use of an ambulance, use of assistive devices, use of therapy); and (3) patients who met both criteria.

The study protocol was reviewed and approved by the University of North Carolina's Institutional Review Board.

Results

Our sample consisted of 23,413 patients discharged home after stroke (supplemental fig S1, available online only at http://www.archives-pmr.org/). Seventy-eight percent of the sample received therapist care during their inpatient stay, but only 40.8% received care in the first 30 days after discharge. Thirty-seven percent of the sample received both inpatient and postacute care, and 18.0% received no acute or postacute therapy. Care was more likely in the home than in the outpatient setting during these first 30 days, with only about 10% of the sample receiving outpatient therapy.

Table 1 presents select sample characteristics stratified by therapist use. Patients who saw a therapist in the inpatient setting were slightly older, more likely to be women and black, had longer lengths of stay, and generally presented with more comorbidities indicative of functional limitations. Differences by demographic and clinical characteristics were more apparent when comparing postacute therapist use, and varied depending on the characteristic and the comparison (eg, home vs outpatient vs no therapist). While patients who received no postacute care generally had lower rates of comorbidities and physical impairments relative to those who received postacute care, in many instances these rates were only slightly lower.

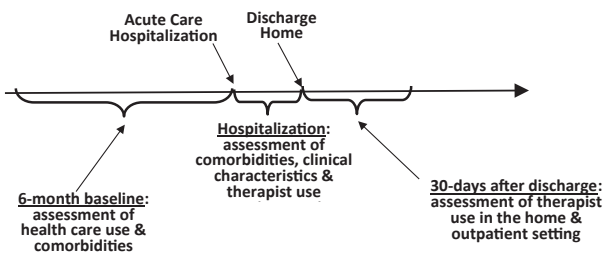


Fig 2 Study design.

For patients who received home health therapy, the mean ± SD and median number of days to the first visit was 5.2±4.6 and 4 days, respectively, and the mean number of visits was 6.8±3.8 (see table 1). For patients who received outpatient therapy, the mean ± SD and median number of days to the first visit was 9.4±7.0 and 7 days, respectively, with a mean ± SD of 5.1±3.4 visits.

Predictors of therapist use in inpatient and postacute settings

Patients treated at hospitals with higher RN staffing levels were more likely to be seen by an inpatient therapist, with a dose-response relationship present (ie, odds ratios increasing as staffing ratios increased from 1.07 to 1.28) (table 2). Other hospital characteristics marginally associated with inpatient therapist use were being treated at a nongovernment, not-for-profit hospital (relative to a for-profit hospital) and being treated at a hospital located in a metropolitan area. Patients living in counties with a greater PCP supply were also more likely to receive inpatient therapist care, with a dose-response relationship present. Patients who were Hispanic or of a lower socioeconomic status were less likely to receive inpatient therapist care.

Patients seen at Joint Commission–accredited hospitals were more likely to receive therapy in the home, and there was some indication of an inverse relationship between bed size and use of therapy in the home. No county-level variables were associated with therapist use in the home. Patients who were black, dual eligible, and lived in counties with lower median household incomes were more likely to be seen by a therapist in the home.

Patients seen in hospitals with a higher proportion of Medicaid discharges were less likely to receive outpatient therapy, while those seen at hospitals with higher RN staffing levels were more likely. We also observed a dose-response relationship with the RN staffing variables. Patients living in counties with a higher PCP supply and physical therapist supply were also more likely to receive outpatient therapy, with dose-response relationships present. Patients who were black or dual eligible were less likely to see an outpatient therapist.

Table 1 Sample characteristics by therapist use (N = 23,413)

	Inpatient Therapist Use		Postacute Therapist Use		
Variables	Yes (78.4%)	No (21.6%)	In Home (30.8%)	Outpatient* (10.0%)	None (59.2%)
Demographic variables					
Male	42.4	43.9	34.0	50.0	46.0
Age (y)	77.8±7.6	76.7±7.3	79.8±7.7	75.8±6.7	76.7±7.3
Race					
White	80.9	82.0	76.4	87.8	82.5
Black	11.6	10.3	15.0	7.0	10.2
Hispanic	2.7	3.6	3.8	1.6	2.7
Other	4.7	4.1	4.8	3.6	4.6
Dual eligibility	26.8	26.6	33.6	14.1	25.3
Hospitalization variables					
Stroke					
Hemorrhagic	11.7	12.7	12.4	10.5	12.0
Ischemic	88.3	87.3	87.6	89.5	88.0
ICU use	38.4	31.8	37.8	36.7	36.6
CCU use	14.8	14.2	15.6	13.2	14.5
Length of stay (d)	3.9±3.5	2.9±2.6	4.6±4.1	3.3±2.9	3.4±2.9
Stroke-related comorbidities during hospitalization					
Aphasia	11.8	7.9	11.4	10.3	10.8
Dysphagia	4.1	2.0	5.8	3.9	2.5
Movement abnormalities	7.8	3.7	8.0	10.8	5.8
Hemiparesis/plegia	17.6	9.0	18.2	21.9	13.4
Fall	0.8	0.6	1.1	0.6	0.5
Elixhauser comorbidities (baseline & hospitalization)					
Comorbidity count					
0—1	10.3	10.3	7.2	12.2	11.9
2—4	36.2	38.6	34.2	41.2	38.9
5—7	27.4	25.7	30.8	26.6	26.6
8—10	14.4	14.7	19.6	12.2	13.2
>10	11.7	10.7	18.3	7.8	9.5
Paralysis	12.9	8.0	18.3	15.9	8.6
Other neurologic	41.0	37.8	53.3	34.3	37.2
Obesity	5.0	4.9	6.4	4.4	4.7
Depression	11.3	10.7	16.6	9.7	9.4
Baseline comorbidities and health care use					
Use of wheelchair	1.8	1.4	3.2	0.8	1.3
Parkinson disease	0.8	0.7	1.3	0.7	0.6
Weakness	0.4	0.4	0.6	0.2	0.3
Vertigo	6.3	7.4	6.8	6.8	6.7
History of a fall	5.0	4.0	8.0	5.3	3.3
Use of oxygen	4.6	4.0	6.6	2.3	4.0
Use of hospital bed	1.0	1.2	2.1	0.3	0.8
Use of assistive devices	1.8	1.6	2.8	1.2	1.4
≥2 Hospitalizations	6.9	6.4	11.1	5.5	5.4
≥1 SNF admissions	2.7	1.9	4.8	1.7	1.7
Use of inpatient PT or OT	10.2	7.9	16.1	9.2	7.3
Use of PT or OT in home	10.1	8.1	21.4	3.8	5.5
Use of outpatient PT or OT	9.8	9.3	10.8	20.3	7.8
Therapist visits					
Received inpatient PT	96.9	0	99.6	87.2	66.5
Received inpatient OT	67.5	0	68.9	68.7	45.3
No. of days to first visit	NA	NA	5.2±4.6	9.4±7.0	NA
Median days to first visit	NA	NA	4	7	NA
No. of visits	NA	NA	6.8±3.8	5.1±3.4	NA

NOTE. Values are %, mean ± SD, or as otherwise indicated.

Abbreviations: CCU, coronary care unit; ICU, intensive care unit; NA, not applicable; OT, occupational therapist; PT, physical therapist; SNF, skilled nursing facility.

* Restricted to patients who saw an outpatient therapist only.

Predictors of continuity of therapist use across settings

Patients seen at Joint Commission–accredited hospitals were more likely to receive continuity of therapist care from the inpatient to home setting, while patients seen at larger hospitals were less likely (table 3). Patients who were black or dual eligible were more likely to have continuity of therapist care across the inpatient and home setting, while patients who lived in counties with higher median household incomes were less likely.

Patients treated at hospitals with a greater proportion of Medicaid discharges were less likely to receive continuity of therapist care across the inpatient and outpatient setting, while patients treated in hospitals with higher RN staffing levels were more likely. Patients living in counties with a greater supply of physical therapists were more likely to receive continuity of therapist care across the inpatient and outpatient setting. The association between increased PCP supply and continuity of care in the inpatient and outpatient setting approached significance. Patients who were black or dual eligible were less likely to have continuity of care across the inpatient and outpatient setting.

Predictors of early postacute therapist care

Patients treated at government hospitals and hospitals with a higher proportion of Medicaid discharges were more likely to receive early therapist care in the home, while those treated at hospitals with a medical school affiliation and larger hospitals were less likely to receive early care in the home (table 4). PCP supply and physical therapist supply were positively associated with early therapist use in the home, while PMR physician supply was inversely associated with early outpatient therapist use. Patients who were black or Hispanic were also less likely to receive early home therapy relative to patients who were white.

Patients treated at not-for-profit hospitals were more likely to receive early outpatient therapist care (see table 4). RN staffing levels were also positively associated with early outpatient therapist use, although these effects were marginal in regard to statistical significance. PCP supply and physical therapist supply were positively associated with early therapist care in the outpatient setting, while PMR physician supply was inversely related to early therapist care in this setting. Sociodemographic disparities in the use of early outpatient therapist care were also present. Patients who were black (relative to white) or dual eligible were less likely to receive early outpatient therapist care.

Sensitivity analyses

The point estimates for the associations observed in our subgroup analyses were generally similar to the estimates for the overall samples, but less precise (ie, wider confidence intervals) because of smaller samples sizes.

Discussion

Our results suggest there may be underutilization of therapists in the care of patients after stroke based on 2 factors: (1) current evidence or guidelines, or both, suggest that rehabilitation begin as soon as possible and be as intensive as possible after stroke[2,8,11,16-18]; and (2) prevalence estimates suggest that 80% to 90% of individuals who sustain a stroke have some degree of motor impairment.[1-3] While 78% of the sample received care in the inpatient setting, only 41% received care in the first 30 days after discharge home, a time when the patient is particularly vulnerable to inactivity, falls, and readmissions.[4-8] Continuity of care across settings was also low. Of those who saw an inpatient therapist, less than half had contact with a therapist in the first 30 days after discharge. Receipt of therapist care after discharge is particularly important since stays in the acute setting are often too short to allow for substantive and complete rehabilitation.

Two consistent findings from our analyses were the positive relationships between RN staffing and therapist use, and PCP supply and therapist use. Patients treated in hospitals with higher RN staffing and living in counties with greater PCP supply were more likely to receive therapist care in the inpatient and outpatient settings and to have continuity of care across the inpatient and outpatient setting. PCP supply was also associated with the receipt of early therapist care in the home and outpatient setting, while RN staffing was associated with early therapist care in the outpatient setting only. A large body of literature has identified a positive relationship between RN staffing levels, patient outcomes, and quality of care.[23,24,34] Our findings support the literature suggesting that hospitals with higher levels of nurse staffing may do a better job in getting patients timely rehabilitation care in the inpatient setting and planning their follow-up care postdischarge. Our findings regarding PCP supply also make theoretical sense because these are the providers patients are most likely to see after being discharged home after stroke. Timely contact with a PCP after hospital discharge can facilitate timely and appropriate access to other care, including therapist care, which requires a physician referral for Medicare patients. While therapist supply was associated with therapist use in some of our models, PCP supply was a more consistent predictor of therapist use across models. These findings suggest that policies to improve the distribution of PCPs may be as important as those to improve therapist distribution.

Contrary to what we expected, physician specialist supply (ie, neurologists and PMR physicians) was not positively associated with therapist use in most models. PMR physician supply, in particular, was inversely related to early therapist use in both the home and outpatient setting. While the reasons behind this are not clear, one explanation may be that PCPs refer to PMR physicians when available, but directly to physical therapists or occupational therapists when the PMR physician supply is low. An alternative explanation is that therapy is overprescribed in areas where PMR physician supply is low.

We found consistent evidence of racial and socioeconomic disparities in therapist use after stroke, particularly in regard to outpatient and early therapist use. Patients who were black or dual eligible were less likely to receive outpatient therapy after discharge home, and less likely to receive early outpatient therapy. Patients treated at hospitals with a higher proportion of Medicaid discharges were also less likely to receive outpatient therapy or to have continuity of care from the inpatient to outpatient setting. While patients who were black were more likely to receive therapist care in the home, they were less likely to receive this care early. Patients who were Hispanic were also less likely to receive early therapist care in the home and to receive inpatient therapist care.

Our findings on racial and socioeconomic disparities identify potential areas to target for improving access, particularly since patients who are black or of a lower socioeconomic status have a greater burden of disease in stroke, greater mortality, and greater

Table 2 Hospital, county, and sociodemographic factors associated with therapist use in the inpatient setting and in the home or outpatient setting (N = 23,413)

Factors	Multivariate Logistic Regression: Therapist Use in Inpatient Setting*		Multivariate, Multinomial Logistic Regression Analysis†			
			Therapist Use in Home		Therapist Use in Outpatient	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Hospital-level characteristics						
Ownership‡						
Government	0.87 (0.73—1.03)	.10	1.04 (0.90—1.20)	.63	1.03 (0.83—1.27)	.77
Other not-for-profit	1.13 (0.99—1.28)	.06	0.93 (0.83—1.03)	.18	1.10 (0.94—1.30)	.24
Joint Commission—accredited hospital	1.07 (0.93—1.23)	.34	1.32 (1.15—1.51)	<.001	0.98 (0.84—1.15)	.82
Medical school affiliation	1.03 (0.93—1.13)	.60	0.97 (0.89—1.06)	.49	1.04 (0.93—1.17)	.48
No. of beds§						
100 to <200	1.05 (0.86—1.28)	.63	0.84 (0.70—1.01)	.06	0.97 (0.75—1.25)	.81
200 to <300	1.07 (0.84—1.35)	.60	0.78 (0.63—0.96)	.02	0.95 (0.71—1.27)	.72
300 to <400	1.08 (0.83—1.40)	.58	0.80 (0.64—1.01)	.06	1.03 (0.75—1.41)	.87
400 to <500	1.12 (0.84—1.50)	.43	0.73 (0.57—0.93)	.01	0.91 (0.65—1.28)	.59
≥500	1.02 (0.76—1.36)	.91	0.80 (0.63—1.02)	.08	0.86 (0.61—1.22)	.40
Medicare discharges/admissions‖						
2nd quartile	1.04 (0.84—1.28)	.74	1.06 (0.88—1.29)	.54	0.82 (0.63—1.07)	.15
3rd quartile	1.13 (0.88—1.45)	.34	0.97 (0.78—1.21)	.80	0.77 (0.57—1.04)	.09
4th quartile	1.18 (0.89—1.57)	.25	1.04 (0.82—1.32)	.76	0.83 (0.60—1.17)	.29
Medicaid discharges/admissions‖						
2nd quartile	1.01 (0.90—1.13)	.87	0.96 (0.88—1.06)	.43	0.94 (0.82—1.08)	.39
3rd quartile	1.01 (0.90—1.13)	.86	1.04 (0.94—1.15)	.43	0.94 (0.82—1.08)	.37
4th quartile	0.91 (0.80—1.03)	.14	0.96 (0.87—1.07)	.51	0.84 (0.72—0.97)	.02
RN FTEs/admissions‖						
2nd quartile	1.07 (0.96—1.20)	.23	0.99 (0.89—1.10)	.84	1.12 (0.97—1.30)	.13
3rd quartile	1.24 (1.10—1.40)	.001	0.98 (0.88—1.09)	.69	1.22 (1.04—1.43)	.01
4th quartile	1.28 (1.13—1.46)	<.001	0.98 (0.88—1.10)	.79	1.35 (1.15—1.57)	<.001
Metropolitan location	1.16 (1.00—1.36)	.05	1.00 (0.87—1.14)	.96	0.87 (0.72—1.04)	.13
County-level variables						
PCPs/population¶						
2nd tertile	1.17 (1.04—1.31)	.009	1.04 (0.94—1.16)	.41	1.10 (0.95—1.28)	.21
3rd tertile	1.29 (1.13—1.46)	<.001	0.97 (0.87—1.09)	.63	1.18 (1.00—1.40)	.04
Neurologists/population¶						
2nd tertile	0.95 (0.83—1.09)	.45	1.02 (0.90—1.16)	.76	0.98 (0.82—1.17)	.84
3rd tertile	0.86 (0.74—1.00)	.05	1.08 (0.94—1.24)	.29	0.95 (0.79—1.16)	.64
PMR physicians/population¶						
2nd tertile	0.96 (0.84—1.10)	.57	1.05 (0.93—1.19)	.45	0.88 (0.74—1.04)	.13
3rd tertile	0.95 (0.82—1.10)	.50	0.99 (0.87—1.14)	.93	0.92 (0.77—1.11)	.41

(*continued on next page*)

Table 2 (*continued*)

Factors	Multivariate Logistic Regression: Therapist Use in Inpatient Setting*		Multivariate, Multinomial Logistic Regression Analysis†			
			Therapist Use in Home		Therapist Use in Outpatient	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Physical therapists/population¶						
2nd tertile	1.01 (0.88—1.15)	.94	1.00 (0.88—1.13)	.96	1.14 (0.94—1.37)	.18
3rd tertile	0.99 (0.85—1.16)	.94	1.04 (0.90—1.19)	.61	1.25 (1.02—1.54)	.03
Metropolitan county	1.03 (0.90—1.18)	.66	1.04 (0.94—1.16)	.41	0.96 (0.80—1.14)	.63
Patient-level sociodemographic characteristics						
Race#						
Black	1.06 (0.93—1.22)	.38	1.27 (1.14—1.41)	<.001	0.83 (0.68—1.00)	.04
Hispanic	0.71 (0.57—0.89)	.003	0.97 (0.79—1.19)	.76	0.93 (0.64—1.35)	.69
Other	1.09 (0.90—1.31)	.37	0.97 (0.83—1.15)	.74	0.91 (0.69—1.21)	.53
Dual eligible	0.96 (0.87—1.05)	.34	1.15 (1.06—1.25)	.001	0.54 (0.47—0.62)	<.001
Median household income‖,**						
2nd quartile	1.17 (1.01—1.35)	.04	0.89 (0.79—1.02)	.09	1.03 (0.84—1.26)	.80
3rd quartile	1.10 (0.94—1.29)	.23	0.83 (0.73—0.95)	.007	1.07 (0.87—1.33)	.50
4th quartile	1.35 (1.15—1.59)	<.001	0.93 (0.82—1.06)	.30	1.13 (0.91—1.40)	.26

Abbreviations: CI, confidence interval; FTE, full-time equivalent.

* Reference no inpatient therapist use, controlling for sex, age, baseline comorbidities and health care use, hospitalization characteristics, and comorbidities.

† Reference no therapist use in home or outpatient setting controlling for sex, age, baseline comorbidities and health care use, hospitalization characteristics, and comorbidities.

‡ Reference for profit.

§ Reference <100 beds.

‖ Reference 1st quartile.

¶ Reference 1st tertile.

Reference white.

** County-level measure.

Table 3 Hospital, county, and patient sociodemographic characteristics associated with continuity of therapy care (N = 18,357*)

	Multivariate, Multinomial Logistic Regression Analysis†			
	Therapist Use in Hospital and Home		Therapist Use in Hospital and Outpatient Setting	
Characteristics	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Hospital-level characteristics				
Ownership‡				
Government	1.12 (0.94—1.32)	.20	1.05 (0.83—1.33)	.68
Other not-for-profit	0.93 (0.82—1.05)	.22	1.12 (0.93—1.34)	.23
Joint Commission—accredited hospital	1.30 (1.13—1.50)	<.001	1.05 (0.87—1.27)	.63
Medical school affiliation	0.95 (0.86—1.04)	.29	1.05 (0.93—1.19)	.44
No. of beds§				
100 to <200	0.81 (0.66—0.99)	.04	0.97 (0.73—1.27)	.80
200 to <300	0.77 (0.61—0.97)	.03	1.00 (0.73—1.38)	.98
300 to <400	0.78 (0.61—1.01)	.06	1.10 (0.78—1.55)	.57
400 to <500	0.69 (0.53—0.91)	.008	0.97 (0.68—1.39)	.87
≥500	0.80 (0.61—1.05)	.11	0.93 (0.64—1.34)	.69
Medicare discharges/admissions‖				
2nd quartile	1.05 (0.84—1.31)	.69	0.80 (0.60—1.08)	.14
3rd quartile	0.93 (0.73—1.20)	.58	0.72 (0.51—1.00)	.05
4th quartile	0.99 (0.75—1.30)	.93	0.75 (0.52—1.08)	.13
Medicaid discharges/admissions‖				
2nd quartile	0.94 (0.85—1.05)	.26	0.92 (0.79—1.06)	.25
3rd quartile	1.05 (0.95—1.17)	.31	0.95 (0.82—1.10)	.50
4th quartile	0.97 (0.86—1.09)	.58	0.83 (0.71—0.98)	.02
RN FTEs/admissions‖				
2nd quartile	0.99 (0.89—1.11)	.92	1.10 (0.93—1.29)	.27
3rd quartile	0.95 (0.85—1.07)	.39	1.16 (0.97—1.37)	.10
4th quartile	0.95 (0.84—1.08)	.44	1.24 (1.05—1.47)	.01
Metropolitan location	0.94 (0.80—1.10)	.45	0.87 (0.71—1.07)	.20
County-level variables				
PCPs/population¶				
2nd tertile	1.02 (0.91—1.14)	.74	1.13 (0.96—1.33)	.13
3rd tertile	0.93 (0.82—1.06)	.28	1.18 (0.99—1.41)	.07
Neurologists/population¶				
2nd tertile	1.05 (0.91—1.20)	.50	0.98 (0.80—1.19)	.81
3rd tertile	1.10 (0.95—1.28)	.21	0.96 (0.78—1.19)	.73
PMR physicians/population¶				
2nd tertile	1.05 (0.91—1.20)	.50	0.85 (0.71—1.03)	.10
3rd tertile	0.98 (0.85—1.14)	.81	0.90 (0.74—1.10)	.32

(*continued on next page*)

Table 3 (*continued*)

Characteristics	Multivariate, Multinomial Logistic Regression Analysis[†]			
	Therapist Use in Hospital and Home		Therapist Use in Hospital and Outpatient Setting	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Physical therapists/population[¶]				
2nd tertile	1.04 (0.91—1.20)	.54	1.10 (0.90—1.34)	.35
3rd tertile	1.10 (0.95—1.28)	.21	1.26 (1.01—1.58)	.04
Metropolitan county	1.05 (0.91—1.20)	.52	0.93 (0.77—1.14)	.50
Sociodemographic characteristics				
Race[#]				
Black	1.28 (1.14—1.44)	<.001	0.80 (0.66—0.98)	.03
Hispanic	0.97 (0.77—1.23)	.83	0.92 (0.61—1.39)	.70
Other	0.98 (0.83—1.17)	.86	0.87 (0.64—1.18)	.37
Dual eligible	1.12 (1.02—1.22)	.02	0.53 (0.46—0.61)	<.001
Median household income[‖,**]				
2nd quartile	0.87 (0.76—1.01)	.07	1.01 (0.81—1.26)	.95
3rd quartile	0.80 (0.69—0.93)	.003	1.06 (0.85—1.34)	.59
4th quartile	0.89 (0.77—1.03)	.13	1.02 (0.83—1.27)	.83

Abbreviations: CI, confidence interval; FTE, full-time equivalent.

* Limited to patients who received inpatient therapy.

† Reference no therapist use in inpatient or postacute setting or therapist use in only 1 of these settings, controlling for sex, age, baseline comorbidities and health care use, hospitalization characteristics, and comorbidities.

‡ Reference for profit.

§ Reference <100 beds.

‖ Reference 1st quartile.

¶ Reference 1st tertile.

Reference white.

** County-level measure.

Table 4 Hospital, county, and patient characteristics associated with early therapist care in the postacute settings (N = 9546)

Characteristics	Multivariate, Multinomial Logistic Regression Results*			
	Early Therapist Use in Home		Early Therapist Use in Outpatient Setting	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Hospital-level characteristics				
Ownership†				
Government	1.30 (1.06–1.61)	.01	1.60 (1.18–2.18)	.003
Other not-for-profit	1.06 (0.91–1.25)	.45	1.49 (1.15–1.92)	.003
Joint Commission–accredited hospital	1.21 (1.00–1.46)	.05	0.76 (0.59–0.98)	.04
Medical school affiliation	0.86 (0.75–0.98)	.02	0.97 (0.81–1.17)	.77
No. of beds‡				
100 to <200	0.77 (0.60–0.98)	.04	1.07 (0.73–1.59)	.72
200 to <300	0.69 (0.51–0.92)	.01	1.13 (0.71–1.79)	.60
300 to <400	0.77 (0.56–1.06)	.11	1.29 (0.78–2.12)	.32
400 to <500	0.75 (0.54–1.06)	.10	1.26 (0.74–2.15)	.39
≥500	0.74 (0.52–1.05)	.09	0.98 (0.57–1.67)	.93
Medicare discharges/admissions§				
2nd quartile	0.95 (0.72–1.24)	.71	0.71 (0.47–1.06)	.09
3rd quartile	1.15 (0.84–1.56)	.39	0.78 (0.49–1.24)	.29
4th quartile	1.15 (0.82–1.63)	.42	0.74 (0.44–1.23)	.25
Medicaid discharges/admission§				
2nd quartile	1.17 (1.02–1.35)	.03	1.13 (0.93–1.39)	.23
3rd quartile	1.23 (1.06–1.42)	.01	1.08 (0.88–1.32)	.48
4th quartile	1.04 (0.89–1.21)	.66	0.80 (0.64–1.01)	.06
RN FTEs/admissions§				
2nd quartile	0.92 (0.80–1.07)	.30	1.02 (0.81–1.28)	.85
3rd quartile	0.96 (0.82–1.12)	.63	1.27 (1.00–1.60)	.05
4th quartile	1.04 (0.89–1.22)	.63	1.24 (0.97–1.57)	.08
Metropolitan location	0.99 (0.81–1.22)	.94	0.93 (0.70–1.23)	.61
County-level variables				
PCPs/population‖				
2nd tertile	1.28 (1.09–1.51)	.003	1.16 (0.93–1.45)	.20
3rd tertile	1.21 (1.01–1.45)	.04	1.34 (1.04–1.73)	.02
Neurologists/population‖				
2nd tertile	0.90 (0.75–1.09)	.28	0.78 (0.60–1.01)	.06
3rd tertile	1.00 (0.81–1.22)	.97	0.85 (0.64–1.14)	.28
PMR physicians/population‖				
2nd tertile	0.97 (0.81–1.15)	.70	0.74 (0.57–0.96)	.03
3rd tertile	0.75 (0.62–0.91)	.004	0.66 (0.50–0.88)	.005

(*continued on next page*)

Table 4 (*continued*)

Characteristics	Multivariate, Multinomial Logistic Regression Results*			
	Early Therapist Use in Home		Early Therapist Use in Outpatient Setting	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Physical therapists/population‖				
2nd tertile	1.17 (0.97—1.42)	.11	1.23 (0.95—1.60)	.12
3rd tertile	1.31 (1.06—1.61)	.01	1.34 (0.99—1.81)	.05
Metropolitan county	1.05 (0.87—1.27)	.59	0.98 (0.76—1.28)	.90
Patient-level sociodemographic characteristics				
Race¶				
Black	0.79 (0.68—0.91)	.001	0.51 (0.38—0.67)	<.001
Hispanic	0.61 (0.46—0.80)	<.001	0.68 (0.38—1.24)	.21
Other	1.01 (0.80—1.27)	.95	0.80 (0.52—1.24)	.32
Dual eligible	1.00 (0.90—1.13)	.93	0.50 (0.41—0.61)	<.001
Median household income§,#				
2nd quartile	1.04 (0.86—1.26)	.67	1.06 (0.80—1.42)	.67
3rd quartile	1.00 (0.82—1.21)	.97	1.24 (0.92—1.67)	.16
4th quartile	0.90 (0.73—1.10)	.30	1.01 (0.74—1.37)	.95

Abbreviations: CI, confidence interval; FTE, full-time equivalent.

* Reference: later therapist use in the home or outpatient setting; controlling for age, baseline comorbidities and health care use, hospitalization characteristics and comorbidities.

† Reference for profit.

‡ Reference <100 beds.

§ Reference 1st quartile.

‖ Reference 1st tertile.

¶ Reference white.

County-level measure.

severity of strokes.[35,36] Unlike care in the home, which is fully covered under Medicare Part A, outpatient therapist care in the traditional Medicare program is covered under Medicare Part B and requires a 20% copayment that patients may have to pay if they do not have supplemental insurance coverage. While approximately 30% of the sample received therapist care in the home, only about 10% used outpatient therapy in the first 30 days. These findings are particularly suggestive of underuse of outpatient therapists after stroke for patients who are not homebound. Payment policy that minimizes out-of-pocket costs for outpatient therapy may help increase access to the underserved and may be an effective way to control downstream health care costs poststroke.

As the population ages and advances in medicine continue to improve the acute care of stroke, the prevalence of strokes survivors is likely to increase. Better efforts and policies are needed to promote access to and continuity in the use of therapists in the acute to postacute transition after stroke, particularly for patients discharged home. One area to target is educating nurses, physicians, and other providers in the acute and postacute settings about the roles of therapists and the importance of early and continued care after discharge home. Seamless communication and information exchange among providers in the acute and postacute settings is also important for effective care coordination and continuity of care. This could potentially be facilitated by the use of electronic health records. Our results underscore the importance of team-based models of care including PCPs, physician specialists, nurses, and therapists. As hospitals move toward accountable care organizations and bundled payments that include both acute and postacute care, strengthening continuity of therapist care across settings may be particularly useful in preventing hospital readmission and other downstream health care costs (eg, costs secondary to a fall).

Study limitations

This study has several limitations. Our findings are limited to Medicare beneficiaries and may not be generalizable to the larger population of stroke survivors. The precision or usefulness of our study variables was also limited. For example, we did not have direct measures of "need" for therapy based on therapist/physician assessment, but rather relied on proxy measures available in our data. In addition, nurse staffing and PCP supply are measures of "structure" or the attributes of settings where health care occurs[37] and do not capture the processes of care (eg, appropriate discharge planning) that facilitate transitions from the acute care to the community setting. We also lacked comprehensive measures of provider supply (eg, occupational therapist supply) and granular measures of geography that may have had some impact on our findings (eg, socioeconomic disparities). Finally, we did not have any measures of patient preference or choice. Future research should explore the reasons underlying the associations we observed and attempt to determine causality.

Conclusions

Therapist use after stroke varies, particularly in the community and especially for specific racial and socioeconomic subgroups, and may be indicative of underutilization. Inpatient nurse staffing levels and primary care provider supply were the most consistent predictors of therapist use, continuity of therapist care, and early therapist use in the community after stroke.

Supplier

a. Stata version 14; StataCorp LLC.

Keywords

Continuity of patient care; Healthcare; Occupational therapists; Physical therapists; Rehabilitation; Stroke

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Supplemental Table S1 ICD-9-CM diagnosis codes to identify stroke

ICD Code	Description	Type of Stroke
430	Subarachnoid hemorrhage	Hemorrhagic
431	Intracerebral hemorrhage	Hemorrhagic
432	Other unspecified hemorrhage	Hemorrhagic
433.01	Basilar artery; with cerebral infarction	Ischemic
433.11	Carotid artery; with cerebral infarction	Ischemic
433.21	Vertebral artery; with cerebral infarction	Ischemic
433.31	Multiple and bilateral; with cerebral infarction	Ischemic
433.81	Other specified precerebral artery; with cerebral infarction	Ischemic
433.91	Unspecified precerebral artery; with cerebral infarction	Ischemic
434.01	Cerebral thrombosis; with cerebral infarction	Ischemic
434.11	Cerebral embolism; with cerebral infarction	Ischemic
434.91	Cerebral artery occlusion, unspecified; with cerebral infarction	Ischemic
435	Transient cerebral ischemia	Transient ischemic attack
435.0	Basilar artery syndrome	Transient ischemic attack
435.1	Vertebral artery syndrome	Transient ischemic attack
435.2	Subclavian steal syndrome	Transient ischemic attack
435.3	Vertebrobasilar artery syndrome	Transient ischemic attack
435.8	Other specified transient cerebral ischemias	Transient ischemic attack
435.9	Unspecified transient cerebral ischemia	Transient ischemic attack
436	Acute, but ill-defined, cerebrovascular disease	Ischemic
437.1	Other generalized ischemic cerebrovascular disease	Ischemic

Abbreviation: ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*.

Supplemental Table S2 Definitions of explanatory and outcome variables

Variable	Definition	Data Source
Sociodemographic variables		
Sex	Male = 1, Female = 0	Medicare Beneficiary Summary File
Age	Age at hospital admission, categorized: 66–70, 71–75, 76–80, 81–85, 86–90, >90 years	
Race	Categorized as white, black, Hispanic, other	
Dual eligibility	Medicare and Medicaid, coded as 1 = yes, 0 = no	
Median household income of patient's county of residence	Categorical variables based on quartile distribution of median household income at the county level	Area Resource File
Hospitalization characteristics		
Patient admitted through emergency department	1 = yes, 0 = no based on type of admission variable	Medicare MedPAR file
Patient transferred from another hospital	1 = yes, 0 = no based on source of admission variable	
Type of stroke	Ischemic, hemorrhagic, or transient ischemic attack. Coded 0 or 1 based on ICD-9-CM codes (see supplemental table S1)	
Stroke code in principal discharge diagnosis	Coded as 1 if principal discharge diagnosis is for stroke, 0 if stroke diagnosis in a secondary position	
Length of stay	Categorized as 1, 2, 3–4, 5–7, 8–10, >10 days	
Use of intensive care	Based on revenue codes for ICU use, coded 1 if yes, 0 if no	
Use of coronary care	Based on revenue codes for ICU use, coded 1 if yes, 0 if no	
Physical therapist use	Based on revenue codes for use, coded as 1 if yes, 0 if no (see supplemental table S3)	
Occupational therapist use	Based on revenue codes for use, coded as 1 if yes, 0 if no (see supplemental table S3)	
Speech therapist use	Based on revenue codes for use, coded as 1 if yes, 0 if no	
Stroke-related comorbidities		
Altered consciousness	ICD-9-CM diagnosis codes 780, 780.0, 780.02, 780.03	Medicare MedPAR file
Aphasia	ICD-9-CM diagnosis codes 438.1, 438.11, 784.3, 784.6	
Dysphagia	ICD-9-CM diagnosis codes 438.82, 787.2, 787.20, 787.21, 787.22, 787.23, 787.24, 787.29	
Aspiration pneumonia	ICD-9-CM diagnosis codes 507, 507.0, 507.1, 507.8	
Decubitus	ICD-9-CM diagnosis codes 707, 707.0, 707.1, 707.10, 707.11, 707.12, 707.13, 707.14, 707.15, 707.19, 707.2, 707.20, 707.21, 707.22, 707.23, 707.24, 707.25, 707.8, 707.9	
Dementia	ICD-9-CM diagnosis codes 290, 290.1, 290.11, 290.3, 290.4, 290.41, 291.0, 292.81, 293.0, 293.1	
Movement abnormalities	ICD-9-CM diagnosis codes 781.0, 781.2, 781.3	
Hemiparesis	ICD-9-CM diagnosis codes 782, 342.ss, 368.46, 781.8, 438.2, 432.12, 438.22, 438.3, 438.31, 438.32, 438.4, 438.41, 438.42, 438.5, 438.51, 438.52, 438.53, 438.6, 438.7, 438.84	
Falls	ICD-9-CM diagnosis codes E880, E880.9, E884.2, E884.3, E884.4, E884.5, E884.6, E884.9, E885, E886.9, E888, E888.0, E888.1, E888.8, E888.9, E9293, 719.7, 719.70, 719.75, 719.76, 719.77, 719.78, 719.79	
Incontinence	ICD-9-CM diagnosis codes 596.5, 596.51–596.55, 596.59, 788.2, 788.20, 788.21, 788.29, 788.3, 788.30–788.39	
Malnutrition	ICD-9-CM diagnosis codes 260, 262, 262, 263, 263.1, 263.2, 26.8, 253.9	
Atrial fibrillation	ICD-9-CM diagnosis codes 427.3, 427.31, 427.32	
Hypertensive heart disease	ICD-9-CM diagnosis codes 402.xx	
Ischemic heart disease	ICD-9-CM diagnosis codes 410.xx–414.xx	
Vascular procedures	ICD-9-CM diagnosis codes 38.11, 28.12, 00.61–00.65, 17.53, 17.54, 38.01, 38.02, 38.31, 38.32, 38.41, 38.42, 38.51, 38.52, 38.61, 38.62, 38.81, 38.83, 39.72, 39.75, 39.76, 39.81–39.89	

(*continued on next page*)

Supplemental Table S2 (*continued*)

Variable	Definition	Data Source
Other comorbidities (Elixhauser comorbidities)		
Elixhauser Comorbidity Index	29 comorbidity variables, see the following link: https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp Created a dichotomous variable for each comorbidity identified during hospitalization and/or during baseline and a categorical count variable (<2, 2—4, 5—7, 8—10, >10 comorbidities)	Medicare MedPAR file, outpatient file, home health file, carrier file
Baseline frailty comorbidities and health care use		
Use of screening tests	HCPCS/CPT codes: G0009, 90669, 90732, 80061, 82465, 83715, 83716, 83717, 83718, 83719, 83720, 83721, 84478, 83700, 83701, 83704, G0101, G0202, 3014F, 76083, 77052, 76092, 77057, 3017F, G0104, G0105, G0106, G0107, G0120, G0121, G0122, G0328, G0102, G0103, 84153, 84154 ICD-9-CM diagnosis codes: V7644, V771, V7791, V761, V7610, V7611, V7612, V7651	Medicare MedPAR file, outpatient file, home health file, carrier file, and durable medical equipment file
Use of wheelchair	CPT/HCPCS codes: 97542, E0950—E0986, E0988, E0990—E1039, E1050, E1060, E1065, E1066, E1069, E1070, E1083—E1093, E1100, E1110, E1130, E1140, E1150, E1160, E1161, E1170—E1172, E1180, E1190, E1195, E1210—E1213, E1220—E1228, E1240, E1250, E1260, E1270, E1280, E1285, E1290, E1295—E1298, E2201—E2228, E2230, E2231, E2300, E2301, E2310—E2313, E2320—E2331, E2340—E2343, E2351, E2358—E2377, E2381—E2397, E2399, E2601—E2633, G9156, K0001—K0109, K0114—K0116, K0195, Ko452, K0460, K0461, K0650—K0669, K0733—K0737, K0813—K0816, K0820—K0831, K0835—K0843, K0848—K0864, K0868—K0886, K0890, K0891, K0898, L3964, L3965, L3966 ICD-9-CM diagnosis codes: V463, V538	
Use of other assistive devices	HCPCS: A4635—A4637, E0100, E0105, E0110—E0114, E0116—E0118, E0130, E0135, E0140—E0149, E0153—E0159, E0163—E0172, E0175, E0240—E0248, K0457—K0459, L0978	
Parkinson disease	ICD-9-CM diagnosis codes: 332, 3320, 3321	
Weakness	ICD-9-CM diagnosis codes: 7282, 7283, 7287, 7993, V4984	
Vertigo	ICD-9-CM diagnosis codes: 386, 3860, 38600, 38601, 38602, 38603, 38604, 3861, 38610, 38611, 38612, 38619, 3862, 43885, 7804	
Falls/difficulty walking	ICD-9-CM diagnosis codes: 7197, 71970, 71975, 71976, 71977, 71978, 71979, 7812, V1588, E880, E8800, E8801, E8809, E8842, E8843, E8844, E8845, E8846, E8859, E888, E8880, E8881, E8888, E8889, E9293	
Incontinence	ICD-9-CM diagnosis codes: 5965, 59651, 59652, 59653, 59654, 59655, 59659, 7882, 78820, 78821, 78829, 7883, 78830, 78831, 78832, 78833, 78834, 78835, 78836, 78837, 78838, 78839	
Decubitus	ICD-9-CM diagnosis codes: 7070, 7071, 70710, 70711, 70712, 70713, 70714, 70715, 70719, 7072, 70720, 70721, 70722, 70723, 70724, 70725, 7078, 7079	
Use of oxygen	HCPCS codes: E0431, E0433, E0434, E0435, E0439, E0441, E0442, E0443, E1390, E1393, K0671	
Use of hospital bed	HCPCS codes: E0250, E0251, E0255, E0256, E0260, E0261, E0265, E0266, E0270, E0290, E0291, E0292, E0293, E0294, E0295, E0296, E0297, E0301, E0302, E0303, E0304, E0316, K0456, K0459, K0550	
Use of ambulance	HCPCS codes: A0426, A0427, A0428, A0429, A0999	
Nail care	HCPCS and CPT codes: 11700, 11701, 11710, 11711, 11719, 11720, 11721, G0127, G0247, M0101	
Hospitalization	Number of hospitalizations during baseline period categorized as 0, 1, 2 or more.	From MedPAR files
Skilled nursing facility admissions	SNF admission during baseline period (Yes or No)	From MedPAR files

(*continued on next page*)

Supplemental Table S2 (*continued*)

Variable	Definition	Data Source
Use of PTs or OTs during baseline	Indicator for outpatient therapy use, home health therapy use, use in short-stay hospital, use in SNF or long-term care hospital (see supplemental tables S3 and S4 for therapy codes)	From MedPAR, outpatient, carrier, home health files
Use of speech therapists during baseline	Indicator for speech therapist use during baseline in an inpatient setting based on revenue center codes	From MedPAR files
Hospital structural and organizational characteristics		
Hospital ownership	Coded as for-profit, not-for-profit government, or not-for-profit other	American Hospital Association data file or CMS Provider of Service File
Medical school affiliation	Coded as yes, no	
RN FTEs/admissions	RN FTEs/number of hospital admissions, created categorical variables based on quartile distribution at hospital level	
Proportion of Medicare discharges	Medicare discharges/admissions, created categorical variables based on quartile distribution at hospital level	
Proportion of Medicaid discharges	Medicaid discharges/admissions, created categorical variables based on quartile distribution at hospital level	
JCAHO accreditation	Coded as yes, no	
Bed size	Categorized as <100, 100 to <200, 200 to <300, 300 to <400, 400 to <500, ≥ 500	
Metropolitan location	Yes if in a micropolitan or metropolitan area, no otherwise	
County-level variables		
Metropolitan county	Micropolitan or metropolitan area, 1 = yes and 0 = no	Area Health Resource File
PTs/county population (10,000)	3-level categorical variable based on tertile distribution of PTs at county level	
Primary care providers/county population (10,000)	3-level categorical variable based on the tertile distribution of PCP providers at county level	
PMR physicians/county population (10,000)	3-level categorical variable based on tertile distribution of PMR physicians at the county level	
Neurologists/county population	3-level categorical variable	
Outcome variables		
Inpatient therapist use	Dichotomous variable: patient received care from based on tertile distribution of neurologists in the county a therapist during his/her index admission for stroke	MedPar, outpatient, home health, and carrier files (see supplemental tables S3 and S4 for specific therapy codes)
Postacute therapist use	Categorical variable: patient received care from a therapist in his/her home in the first 30 days after discharge, patient received care from a therapist in an outpatient setting in the first 30 days, patient did not receive care from a therapist in the first 30 days. Patients who received care in the home and outpatient setting were categorized based on first setting where care was received.	
Inpatient and postacute therapist use	Categorical variable: patient received care from a therapist during his/her inpatient stay and in the home, patient received care from a therapist during his/her inpatient stay and in an outpatient setting, patient received inpatient care only or postacute care only	
Early postacute care therapist use	Categorical variable: patient received home health within first 3 days after discharge home, patient received outpatient care within the first 6 days after discharge home, patient received therapist care later	

Abbreviations: CMS, Centers for Medicare and Medicaid Services; CPT, Current Procedural Terminology; FTE, full-time equivalent; HCPCS, Healthcare Common Procedure Coding System; ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*; ICU, intensive care unit; JCAHO, Joint Commission of Accreditation of Healthcare Organizations; OT, occupational therapist; PT, physical therapist; SNF, skilled nursing facility.

Supplemental Table S3 Revenue center codes for therapy

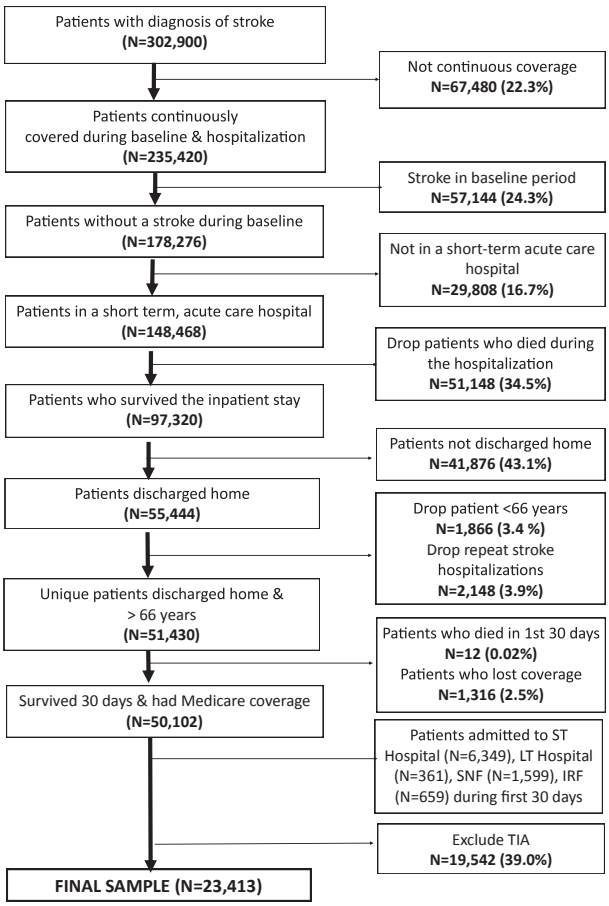
Revenue Center Codes
0420 = Physical therapy—general classification
0421 = Physical therapy—visit charge
0422 = Physical therapy—hourly charge
0423 = Physical therapy—group rate
0424 = Physical therapy—evaluation or re-evaluation
0429 = Physical therapy—other
0430 = Occupational therapy—general classification
0431 = Occupational therapy—visit charge
0432 = Occupational therapy—hourly charge
0433 = Occupational therapy—group rate
0434 = Occupational therapy—evaluation or re-evaluation
0439 = Occupational therapy—other (may include restorative therapy)
0977 = Professional fees—physical therapy
0978 = Professional fees—occupational therapy

Supplemental Table S4 Therapy CPT/HCPCS codes*

Codetype	Code	Description	Codetype	Code	Description
Proc CPT	64550	Apply neurostimulator	Proc CPT	97032	Electrical stimulation
Proc CPT	90901	Biofeedback train, any meth	Proc CPT	97033	Electric current therapy
Proc CPT	90911	Biofeedback peri/uro/rectal	Proc CPT	97034	Contrast bath therapy
Proc CPT	92506	Speech/hearing evaluation	Proc CPT	97035	Ultrasound therapy
Proc CPT	92507	Speech/hearing therapy	Proc CPT	97036	Hydrotherapy
Proc CPT	92508	Speech/hearing therapy	Proc CPT	97039	Physical therapy treatment
Proc CPT	92520	Laryngeal function studies	Proc CPT	97110	Therapeutic exercises
Proc CPT	92526	Oral function therapy	Proc CPT	97112	Neuromuscular reeducation
Proc CPT	92597	Oral speech device eval	Proc CPT	97113	Aquatic therapy/exercises
Proc CPT	92605	Ex for nonspeech device rx	Proc CPT	97116	Gait training therapy
Proc CPT	92606	Nonspeech device service	Proc CPT	97124	Massage therapy
Proc CPT	92607	Ex for speech device rx, 1h	Proc CPT	97139	Physical medicine procedure
Proc CPT	92608	Ex for speech device rx addl	Proc CPT	97140	Manual therapy
Proc CPT	92609	Use of speech device service	Proc CPT	97150	Group therapeutic procedures
Proc CPT	92610	Evaluate swallowing function	Proc CPT	97530	Therapeutic activities
Proc CPT	92611	Motion fluoroscopy/swallow	Proc CPT	97532	Cognitive skills development
Proc CPT	92612	Endoscopy swallow tst (fees)	Proc CPT	97533	Sensory integration
Proc CPT	92614	Laryngoscopic sensory test	Proc CPT	97535	Self-care management training
Proc CPT	92616	Fees w/laryngeal sense test	Proc CPT	97537	Community/work reintegration
Proc CPT	92618	Ex for nonspeech dev rx add	Proc CPT	97542	Wheelchair management training
Proc CPT	95831	Limb muscle testing, manual	Proc CPT	97597	Rmvl devital tis 20cm/<
Proc CPT	95832	Hand muscle testing, manual	Proc CPT	97598	Rmvl devital tis addl 20cm<
Proc CPT	95833	Body muscle testing, manual	Proc CPT	97602	Wound(s) care nonselective
Proc CPT	95834	Body muscle testing, manual	Proc CPT	97605	Neg press wound tx, <50cm
Proc CPT	95851	Range-of-motion measurements	Proc CPT	97606	Neg press wound tx, >50cm
Proc CPT	95852	Range-of-motion measurements	Proc CPT	97750	Physical performance test
Proc CPT	95992	Canalith repositioning proc	Proc CPT	97755	Assistive technology assessment
Proc CPT	96105	Assessment of aphasia	Proc CPT	97760	Orthotic mgmt and training
Proc CPT	96110	Developmental test, lim	Proc CPT	97761	Prosthetic training
Proc CPT	96111	Developmental test, extend	Proc CPT	97762	C/O for orthotic/prosth use
Proc CPT	96125	Cognitive test by HC pro	Proc CPT	97799	Physical medicine procedure
Proc CPT	97001	PT evaluation	Proc CPT	0019T	Extracorp shock wv tx ms NOS
Proc CPT	97002	PT re-evaluation	Proc CPT	0183T	Wound ultrasound
Proc CPT	97003	OT evaluation	Proc HCPCS	G0281	Elec stim unattend for press
Proc CPT	97004	OT re-evaluation	Proc HCPCS	G0283	Elec stim other than wound
Proc CPT	97010	Hot or cold packs therapy	Proc HCPCS	G0329	Electromagntic tx for ulcers
Proc CPT	97012	Mechanical traction therapy			
Proc CPT	97016	Vasopneumatic device therapy			
Proc CPT	97018	Paraffin bath therapy			
Proc CPT	97022	Whirlpool therapy			
Proc CPT	97024	Diathermy, eg, microwave			
Proc CPT	97026	Infrared therapy			
Proc CPT	97028	Ultraviolet therapy			

Abbreviations: addl, additional; C/O, care of; CPT, Current Procedural Terminology; dev, device; devital, devitalized; Elec, electric; eval, evaluation; Electromagntic, electromagnetic; Ex, exercise; Extracorp, extracorporeal; HC, healthcare; HCPCS, Healthcare Common Procedure Coding System; lim, limited; meth, method; ms, musculoskeletal system; Neg, negative; NOS, not otherwise specified; OT, occupational therapy; press, pressure; pro, professional; Proc, procedure; prosth, prosthetic; PT, physical therapy; Rmvl, removal; rx, prescription; stim, stimulation; tis, tissue; tst, test; tx, treatment; w/, with; wv, wave.

* For this analysis, speech-related codes and wound therapy codes were excluded.



Supplemental Fig S1 Cohort creation. Abbreviations: IRF, inpatient rehabilitation facility; LT, long-term; SNF, skilled nursing facility; ST, short-term; TIA, transient ischemic attack.