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Rehabilitation Therapy Doses Are Low After Stroke And Predicted By Clinical Factors

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On behalf of the STRONG Study Investigators

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Abstract

Background: Stroke is a leading cause of long-term disability. Greater rehabilitation therapy after stroke is known to improve functional outcomes. This study examined therapy doses during the first year of stroke recovery and identified factors that predict rehabilitation therapy dose.

Methods: Adults with new radiologically confirmed stroke were enrolled 2–10 days after stroke onset at 28 acute care hospitals across the U.S. Following an initial assessment during acute hospitalization, the number of physical therapy (PT), occupational therapy (OT), and speech therapy (ST) sessions were determined at visits occurring 3-, 6-, and 12-months following stroke. Negative binomial regression examined whether clinical and demographic factors were associated with therapy counts. False discovery rate was used to correct for multiple comparisons.

Results: Of 763 patients enrolled during acute stroke admission, 510 were available for follow-up. Therapy counts were low overall, with most therapy delivered within the first 3 months; 35.0% of patients received no PT; 48.8%, no OT, and 61.7%, no ST. Discharge destination was significantly related to cumulative therapy; the percentage of patients discharged to an inpatient rehabilitation facility varied across sites, from 0–71%. Most demographic factors did not predict therapy dose, although Hispanic patients received a lower cumulative amount of PT and OT. Acutely, severity of clinical factors (grip strength and NIHSS score, as well as NIHSS subscores for aphasia and neglect) predicted higher subsequent therapy doses. Measures of impairment and function (Fugl-Meyer, mRS, and SIS-ADL) assessed 3 months after stroke also predicted subsequent cumulative therapy doses.

Conclusions: Rehabilitative therapy doses during the first-year post-stroke are low in the U.S. This is the first U.S.-wide study to demonstrate that behavioral deficits predict therapy dose,

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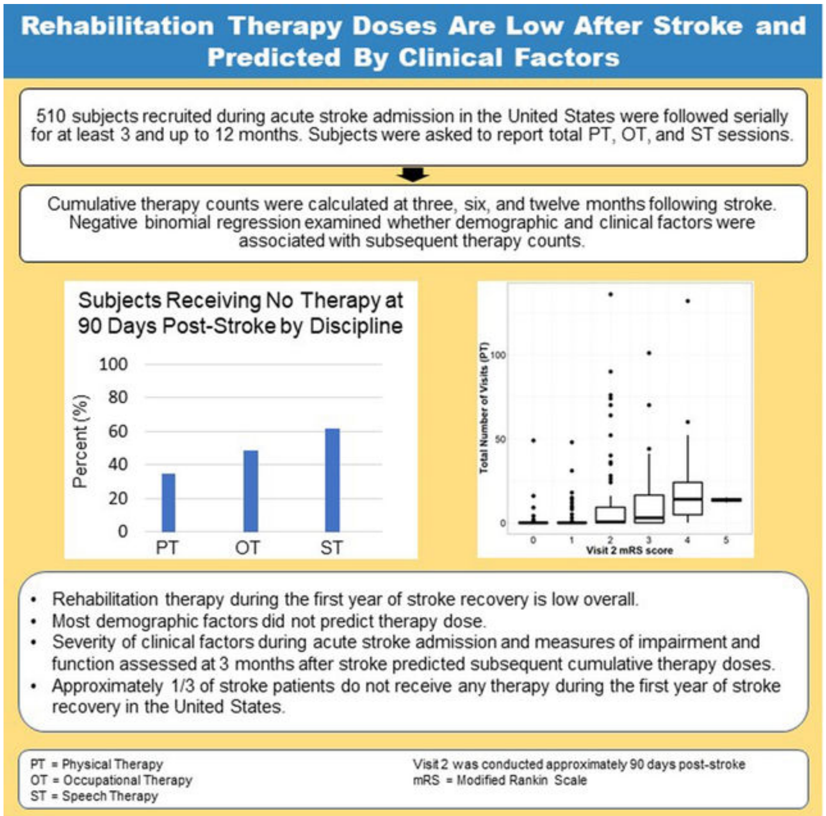
Supplemental Material:
Table S1
Figure S1
Table S2

with patients having more severe deficits receiving higher doses. Findings suggest directions for identifying groups at risk of receiving disproportionately low rehabilitation doses.

Graphical Abstract



Keywords

stroke; rehabilitation; therapy dose; therapy prediction; United States

Introduction

Stroke remains a leading cause of serious long-term disability in the U.S. Higher doses of rehabilitation therapy after stroke produce superior functional outcomes[1–9]. During the subacute stroke period, increasing therapy beyond usual care yields greater functional recovery than usual care alone[1,2] – as little as 16 additional rehabilitation therapy hours during the first six months post-stroke is associated with a significant increase in ability to perform activities of daily living[3]. Benefits from added therapy do not demonstrate a plateau at any dose[6].

Despite strong evidence that stroke rehabilitation therapy reduces long-term disability, it is highly variable and generally underutilized in the U.S.[10]. Observational studies of standard rehabilitative therapy components (i.e., physical therapy (PT), occupational therapy (OT), and speech therapy (ST)) show that patients generally receive small and inconsistent amounts of therapy in the post-acute stroke care settings[11–14].

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Increased participation in outpatient stroke rehabilitation has been recognized as a national priority[11]. Although an assessment for rehabilitation occurs in 89.5% of patients during the acute stroke admissions[15], a substantial gap remains in the degree to which such therapy is actually provided after discharge. A study of 13,550 Medicare patient records found that >30% of stroke patients receive no post-acute rehabilitation therapy in the first 30 days after discharge[12], and a later study of 23,413 Medicare patient records found that 59% of patients with stroke discharged from acute care to home did not see a PT or OT in the first 30 days after discharge[16].

A better understanding of the factors that influence the amount of rehabilitation therapy is needed to formulate solutions. Some[11,13], but not all[14,17], prior studies suggest key factors, including gender, race, ethnicity, education, and geographic area, that may impact the likelihood of stroke rehabilitation after discharge from the inpatient setting. One possible explanation for conflicting findings is that most studies rely on review of billing records to extract measures associated with rehabilitation dose. While this approach has advantages, it generally does not permit assessment of detailed clinical measurements. The current study addressed factors related to rehabilitation dose after stroke by following patients with four examinations, from acute admission to 1-year post-stroke, hypothesizing that rehabilitation doses would be low, provided to those with the most severe deficits, and predicted by several demographic and clinical factors.

Methods

Subject Recruitment

The STRONG ("The Stroke, sTress, RehabilitatiON, and Genetics Study") Study was an observational prospective cohort study that recruited patients with a new stroke from 28 U.S. acute care hospitals (listed in Supplementary Materials). The STRONG Study was a longitudinal multi-center study with primary aim to identify genetic correlates of stroke recovery. Genetic analyses will be reported elsewhere. Entry criteria included age ≥18 years, radiologically confirmed ischemic stroke or intracerebral hemorrhage with onset 2–10 days prior to enrollment, ability to demonstrate effective communication in English and provide responses to study assessments. Subjects were excluded for expected survival less than one year, pre-stroke moderate-severe disability (modified Rankin scale (mRS) score>2), an active major neurological or psychiatric diagnosis prior to the index stroke, or additional stroke <90 days prior to the index stroke. The data that support the findings of this study are available from the corresponding author upon reasonable request.

There were 763 patients enrolled in the STRONG study between October 2016 and February 2020 during acute stroke admission. Data were available in 510 patients at Visit 2 (3-months); 493, at Visit 3 (6-months); and 482, at Visit 4 (12-months). Patient dropout was due to two main factors: mortality and inability to travel the distance back to the enrollment site for Visit 2. Of note, 75% of drop-outs occurred prior to Visit 2. Most subjects who dropped out prior to Visit 2 withdrew consent, precluding subsequent testing at telephone Visits 3–4.

This study was approved by the local IRB at each participating institution. All subjects provided informed consent with no surrogate consent permitted.

Subject Assessment Schedule

Visit 1 was a live exam 48–240 hours after stroke onset. Data included demographic and medical history, discharge destination from the acute care hospital, and initial NIH Stroke Scale[18,19] (NIHSS) score from the medical record. Aphasia and neglect were measured using NIHSS questions 9 and 11, respectively. Grip strength in each hand was tested three times then averaged, using a calibrated Jamar dynamometer, and expressed as the ratio of the more-affected to the less-affected hand.

Visit 2 was a live exam 3 months after stroke onset. Assessments included interval medical history and self-reported socioeconomic status using a visual ladder tool with 10 rungs. This live exam included additional scales: Fugl-Meyer Upper Extremity (FM) assessment[20–22], modified Rankin Scale[23] (mRS), Stroke Impact Scale 3.0[24] Activities of Daily Living subsection (SIS-ADL)[24], and Personal Health Questionnaire Depression Scale[25] (PHQ-8). Visit 3 and Visit 4 occurred via telephone and included the PHQ-8. At Visits 2–4, patients were asked, since the prior Visit, how many days they had with one or more sessions that had at least 1 minute of active intervention, separately for PT, OT, and ST.

Statistical Analyses

All statistical analyses were performed in R version 4.1.2[26]. Relationships between continuous or ordinal variables and therapy counts were analyzed using negative binomial regression, a model well suited to the analysis of count data (therapy visit number) containing a large number of zeros, which are features of these distributions. Negative binomial models demonstrated a better fit to the data acquired in this study as compared to Poisson regression models using likelihood ratio testing. Negative binomial regression was also used when investigating possible relationships between categorical variables and therapy counts when a continuous or ordinal variable was covaried in the model. Potential relationships between categorical variables and therapy counts were evaluated using Kruskal-Wallis testing.

When evaluating relationships between demographic factors (i.e., age, gender, race, ethnicity, education level, socio-economic status, stroke type, baseline antidepressant use, and study site) and therapy doses, stroke severity (initial NIHSS score) was added as a covariate to models. When evaluating relationships between two categorical variables (site and discharge destination), Fisher’s exact test was used. These relationships were further investigated using a nominal logistic fit to allow adding initial NIHSS as a covariate reflecting stroke severity. When evaluating for differences between subjects with and without missing data, Kruskal-Wallis testing was used for continuous and ordinal variables; Fisher’s exact testing was used for categorical variables.

When evaluating for potential change in PHQ8 scores between visits, a one sample sign test of paired differences was used.

Given the large number of statistical tests performed among multiple variables, when assessing for significance, p values were adjusted for multiple comparisons using false discovery rate (FDR) correction[27]. All p values reported reflect an a priori threshold for significance that was set at an FDR-corrected p value of p<0.05. This manuscript follows the STROBE[28] reporting guidelines.

Results

Subject Characteristics and Retention

Baseline clinical features, recorded 4 [3–6] (median [IQR]) days after stroke onset, appear in Table 1 for those who reached Visit 2. Visit 2 occurred 100 [91–125] days after stroke onset; Visit 3, 188 [179–202] days; and Visit 4, 365 [353–379] days. Subjects who dropped out (Supplemental Figure S1) did not significantly differ from those who did not with respect to any of the variables in Table 1. Study site was related to patient dropout at Visit 2 (p=0.02) but not at Visit 3 or Visit 4.

Amount of Rehabilitation Therapy

Between acute stroke and 3 months, 65.0% of patients received any PT; 51.2%, any OT; and 38.3% any ST. From 3 to 6 months, 32.3% received further PT; 20.5% further OT, and 12.9% further ST. From 6 to 12 months, 22.7% received further PT; 12.3% further OT, and 8.0% further ST. At Visit 2, 31.6% of subjects reported having received no therapy of any kind (i.e. no PT, OT, or ST). At Visits 3 and 4, 32.3% and 28.8% of subjects respectively reported having received no cumulative therapy of any kind (Supplemental Table B). The cumulative amount of therapy that patients reported at each time point is summarized in Table 2, separately for PT, OT, and ST. On average, therapy dose was highest for PT, followed by OT, then ST. For all three types of therapy, the majority of therapy during the first year after stroke occurred by Visit 2--more than half of any therapy received within each discipline over the course of the first-year post-stroke was provided within the first 90 days of discharge.

Few Demographic Factors Were Associated With Amount of Rehabilitative Therapy.

Of the demographic data collected acutely (Visit 1), age, gender, education level, self-reported socio-economic status, baseline antidepressant use, and stroke type were not related to the cumulative amount of therapy, at any time point, for any of the three types of therapy.

However, ethnicity and race were significantly related to rehabilitation therapy doses in two instances (Table 3). Hispanic patients received a lower cumulative amount of PT and OT, but not ST, at several timepoints during the first-year post-stroke. In addition, cumulative ST at Visit 2 was lower among Asian patients compared to White patients (rate ratio 0.274, confidence interval 0.094–0.800, p<0.05).

Study site was related to cumulative therapy dose, for all three therapy types at Visit 2 (p<0.05 for all types). This relationship persisted at Visits 3 and 4 for OT (p<0.05 at both visits) and ST (p < 0.01 at both visits). This may in part reflect differences in discharge destination, which varied by study site (p<0.01, Figure 1), even when controlling for initial NIHSS score ($p<0.01$). For example, the percentage of patients discharged to an inpatient rehabilitation facility varied across sites, from 0–71%. Discharge destination was significantly related to cumulative therapy, for all three therapy types, at Visits 2–4 ($p<0.01$ for each therapy type at each visit), with those discharged to home reporting less cumulative therapy; this effect persisted even when initial NIHSS was added as a covariate.

Clinical Measures Assessed Acutely Were Associated With Subsequent Amount of Rehabilitative Therapy

Several clinical measures assessed during the acute stroke hospitalization were related to subsequent doses of PT, OT, and ST during the first year of stroke recovery (Table 3). Higher initial NIHSS score and weaker grip strength were each significantly associated with larger cumulative therapy doses, for all three therapy types, at all three time points ($p<0.01$ for each therapy type at each visit). Similarly, lower initial NIHSS scores were associated with an increased odds of receiving no therapy throughout the study (Supplemental Table B). Patients with more severe hemineglect had larger amounts of each therapy at all visits, except for OT at Visit 2. Furthermore, greater aphasia severity acutely was significantly associated with higher cumulative amount of ST but not OT or PT, at all three time points during the year following stroke (Table 3).

Clinical Measures Assessed 3 Months After Stroke Were Also Associated With Subsequent Amount of Rehabilitative Therapy

Doses of PT, OT, and ST at Visits 3–4 (Table 2) were predicted by performance on motor impairment and functional assessments scored at Visit 2 (100 days post-stroke). These predictions appear in Table 4 and indicate that greater arm motor impairment (lower Fugl-Meyer Upper Extremity score), greater global disability (higher mRS score, Figure 2), and poorer functioning in ADLs (lower SIS-ADL) at Visit 2 were each significantly associated with higher doses of subsequent PT, OT, and ST.

Being on an antidepressant medication at Visit 2 (n=153) was significantly associated with larger amounts of therapy in all modalities in the short-term (Visit 2–3, $p<0.01$ for OT and PT, $p<0.05$ for ST) and longer-term (V2–4, $p<0.01$ for all therapies). A rate ratio was not available because these analyses used Kruskal-Wallis testing. Interestingly, no significant relationships were found between degree of depression at Visit 2 (PHQ8 score) and subsequent doses of therapy, for any therapy discipline, at either subsequent timepoint.

Discussion

Increased rehabilitation therapy after stroke results in better functional outcomes, in a dose-dependent manner[1–9] but remains underutilized[11], particularly among certain subpopulations[13,29,30]. In the context of the STRONG Study, which followed U.S. patients for one year after acute stroke, we examined doses of rehabilitation therapy. Rehabilitation doses were low overall, consistent with prior studies. Novel findings include that patients with more severe deficits received larger doses of rehabilitation therapy, and that clinical factors were better overall than demographic as predictors of rehabilitation therapy dose.

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Together, these findings reinforce that U.S. patients receive limited rehabilitation therapy after stroke and suggest directions for addressing this unmet need.

Total Therapy Was Low During the Year Following Stroke

Many patients in this multisite study did not receive any rehabilitation therapy after their stroke: by 3-months post-stroke, 35.0% of patients received no PT, 48.8% no OT, and 61.7% no ST. This finding is consistent with prior studies, e.g., 40% of patients with stroke were discharged home from the acute stroke admission without any rehabilitation services[15]. Results are consistent across data collection methods, as whether relying on retrospective self-report[11], similar to the current study, or review of medical records[16], 65–69% of patients did not recall receiving any rehabilitation therapy[11] or have billing records that indicated any therapy within 30 days of hospital discharge[16]. Current findings may in part reflect that the enrolled population had on average mild-moderate strokes, although strokes in this severity range are nonetheless often associated with enduring disability[31,32] and so may benefit from rehabilitation therapy. The current report adds to this literature by noting that the lowest levels of rehabilitation therapy were received by patients discharged home, a finding that was independent of initial stroke severity.

Among those who did receive therapy, the average dose received was variable and low. The median number of sessions was 6–8 at three months, depending on the type of therapy, and 0–1.5 sessions thereafter. The total number of therapy sessions approximates the maximum amount of therapy expected under Medicare[33]. These results are also consistent with prior studies. For example, therapy dose based on billing records within single-payer systems averages 5.7–7.5 therapy visits within the first 30 days of discharge among Medicare patients[16] and 24.4 therapy visits over the course of the first year among patients in one Kaiser Permanente system[13]. In Medicare patients, the median amount of therapy was 11.0–12.7 hours across disciplines among those who received at least some therapy over the course of the first year[14]. The change in therapy dose over the year following a stroke has received less study, although one study found the average number of OT, PT, and ST sessions at 3 months was more than half the number at 6 months, consistent with current results[34]. Therapy dosing was highly variable across patients, ranging from no therapy to hundreds of therapy sessions, with the median being consistently lower than the mean amount of cumulative therapy sessions (Table 2). Similar right-tailed effects have been noted in prior studies examining the distribution of rehabilitation therapy doses[13,14]. This relationship persisted throughout the entire first year of recovery (Table 2).

The low doses of rehabilitation therapy observed in this study contrast with prior findings that higher doses are associated with a number of favorable outcomes, including reduced hospital readmission rates[16,35] and increased functional recovery[1–9], although most of these data come from studies that administered supplemental therapy in a clinical trial setting. The literature indicates that increasing the therapy dose to more than twice that of usual care had the highest likelihood for improved activity[8]. Gains in language comprehension were found only after reaching a total ST dose of at least 20 hours[36]. Current findings thus suggest that the low therapy doses after stroke in the U.S. are below the maximal effective dosing and so contribute to incompletely realized functional gains in this population.

Study Site was Related to Cumulative Dose of Rehabilitation Therapy and Discharge Destination

Study site demonstrated a relationship with subsequent therapy dose, even after accounting for initial stroke severity. To our knowledge, this 28-site study is the first study to establish that cumulative dose of rehabilitation therapy varies substantially across acute stroke care treatment sites. This is consistent with a prior analysis that found site-specific variation in motor and cognitive function at discharge after post-acute rehabilitation in patients with stroke, with site having a greater effect than geographic location on functional outcomes[37]. Discharge destination varied by study site (Figure 1), with the percentage of patients discharged to an inpatient rehabilitation facility varying from 0–71%. This is consistent with prior findings of significant geographic variation in rehabilitation therapy dose among Medicare patients with stroke in both the acute[38] and post-acute[12,39] care settings, and so the observed variation in therapy dose may be due, in part, to inter-site differences in patterns of discharge destination after acute stroke.

In the Acute Setting, Clinical Factors were Better than Demographic Factors at Predicting Subsequent Therapy Dose

Multiple clinical measures assessed during acute care admission following initial stroke presentation were associated with subsequent amount of rehabilitation therapy. Higher initial NIHSS score and weaker grip strength were each associated with larger therapy doses throughout the subsequent year. Greater neglect acutely was also associated with increased therapy during the year following stroke. The predictive relationships between clinical measures assessed acutely and subsequent rehabilitation therapy doses demonstrated some degree of specificity, as greater initial aphasia severity was consistently associated with an increase in only ST during the subsequent year, even with the overall low rehabilitation therapy doses provided.

Although patients with a greater extent of impairment from stroke might intuitively be expected to receive higher therapy doses due to greater therapy needs, to our knowledge this is the first study to demonstrate the relationship between clinical measures of acute stroke severity and subsequent rehabilitation therapy doses (Table 3), and that this relationship persists throughout the first year of recovery (Table 4). Most prior longitudinal observational studies of therapy relied on billing records or telephone surveys and therefore were unable to collect detailed clinical assessments during the acute stroke admission. Current findings suggest that although total therapy counts were low, those with greater therapy needs generally received greater therapy doses, throughout the year following stroke onset.

Of the demographic factors related to rehabilitation therapy dose, only race and ethnicity showed significant relationships with amount of subsequent rehabilitation therapy. Hispanic ethnicity was associated with lower amounts of PT and OT. There has been limited study on the effect of ethnicity on rehabilitation dose after stroke, though one study focused on inner city subjects found no significant differences in PT, OT, or ST in the first 90 days after stroke across ethnic groups[40]. Multiple differences in study design and study population complicate comparison of that study with current findings. Equitable access to post-stroke therapies across ethnicities warrants attention. Other factors previously found related to rehabilitation therapy dose, such as age, sex, and stroke type[13,30,41], were not related to therapy dose during the first year of stroke recovery in the current heterogeneous cohort. Changes in rehabilitation prescription over time, method of measuring therapy dose, or study population might explain these divergent results.

At Three Months Post-Stroke, Clinical Measures Remained Predictors of Subsequent Rehabilitation Therapy Dose

Just as clinical measures during acute stroke admission predicted therapy doses during the first year of recovery, motor impairment and functional assessments at three months post-stroke also had predictive value for subsequent cumulative therapy doses. Greater arm motor impairment, greater global disability, and poorer functioning in ADLs at three months post-stroke were each significantly associated with higher cumulative doses of PT, OT, and ST over the remainder of the first year. The relationship between clinical status at three months and subsequent dose of rehabilitation therapy has not previously been reported. Although therapy doses after three months were sparse, these findings indicate that, as least for some patients, assessment and treatment of impairment and disability remain an ongoing process.

Antidepressant use at three months post-stroke was also significantly associated with higher doses of subsequent rehabilitation therapy, across all disciplines, throughout the remainder of the first year. No such relationships were observed between pre-stroke antidepressant use and subsequent dose of rehabilitation therapy. Interestingly, severity of depression three months post-stroke did not predict subsequent therapy doses, suggesting that the relationship between antidepressant use and increased rehabilitation therapy three months after stroke was not simply a function of depressive symptoms. Antidepressant use three months post-stroke may instead represent a marker for engagement with the health system rather than a direct contributing factor to subsequent increased therapy dose. These results may be important given that depression is associated with reduced physical activity after stroke[42] and poorer functional outcomes[43], and so engagement with the health system may contribute to improved outcomes after stroke[29].

Limitations

The current study had several limitations. Therapy doses were self-reported. One study of patients with stroke found moderate agreement (Cohen's kappa=0.56) between amount of rehabilitation therapy using patient-reported values compared to billing data[44], with each method having its own set of limitations. The stroke population studied was heterogeneous, and results might have differed if enrollment was restricted to subjects known to have ongoing therapy needs[41,45]. No data were collected regarding specific content or intensity of rehabilitation therapy, which may also be important. For example, a patient who reported a session of ST may have had therapy targeted to address language deficits or therapy targeting dysphagia. In addition, no data were collected regarding subjects' medical insurance status or the population density of their home communities. Study site was related to patient dropout at Visit 2 only, a finding that may reflect reduced power to detect a relationship at Visits 3 and 4 due to fewer dropouts at these two timepoints, although this result may also be due to different barriers to study participation for a live (Visit 2) vs.

telephone (Visits 3–4) visit. Finally, subject dropout was substantial, with approximately one third of patients lost to follow-up, although this concern may be mitigated by the finding that there were no significant differences in any baseline characteristic between subjects who were and were not lost to follow-up.

Conclusions

Rehabilitative therapy doses during the first year following a stroke in the U.S. are low and highly variable in relation to several factors, including those related to treatment site, patient demographics and clinical status, and engagement with the health system. Some of these can be measured during the acute stroke admission, suggesting the potential to address imbalances in allocation of rehabilitation therapy after stroke by identifying patients with disability at risk for low doses of rehabilitation therapy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

Table A.

List of the STRONG Study Investigators, in alphabetical order by study site

Author Name	Study Site
Shreyansh Shah, MD	Duke University
Christoph J. Griessenauer, MD	Geisinger Health; Geisinger Commonwealth School of Medicine
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Joey Gee, DO	Providence Mission Hospital Mission Viejo
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Stacey DeJong, PT, PhD	University of Iowa
John Cole, MD, MS	University of Maryland

Author Name	Study Site
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Sook-Lei Liew, PhD, OTR/L	University of Southern California
Susan Alderman, PhD, RN	University of Texas, Houston
Heather Hayes, PT, PhD, DPT; Jennifer J. Majersik, MD, MS	University of Utah
Brad Worrall, MD	University of Virginia
David Tirschwell, MD, MSc	University of Washington
Cheryl Bushnell, MD, MHS; Nadia El Husseini, MD, MHS	Wake Forest School of Medicine
Jin-Moo Lee, MD, PhD	Washington University in St. Louis
Guido J. Falcone, MD, ScD, MPH	Yale University

Non-Standard Abbreviations and Acronyms:

PT Physical Therapy

OT Occupational Therapy

ST Speech Therapy

FM Fugl-Meyer Upper Extremity Scale

mRS modified Rankin Scale

SIS-ADL Stroke Impact Scale Activities of Daily Living Scale

PHQ-8 Personal Health Questionnaire Depression Scale

FDR False Discovery Rate

NS Not Significant

IRF Inpatient Rehabilitation Facility

SNF Skilled Nursing Facility

ACH Acute Care Hospital

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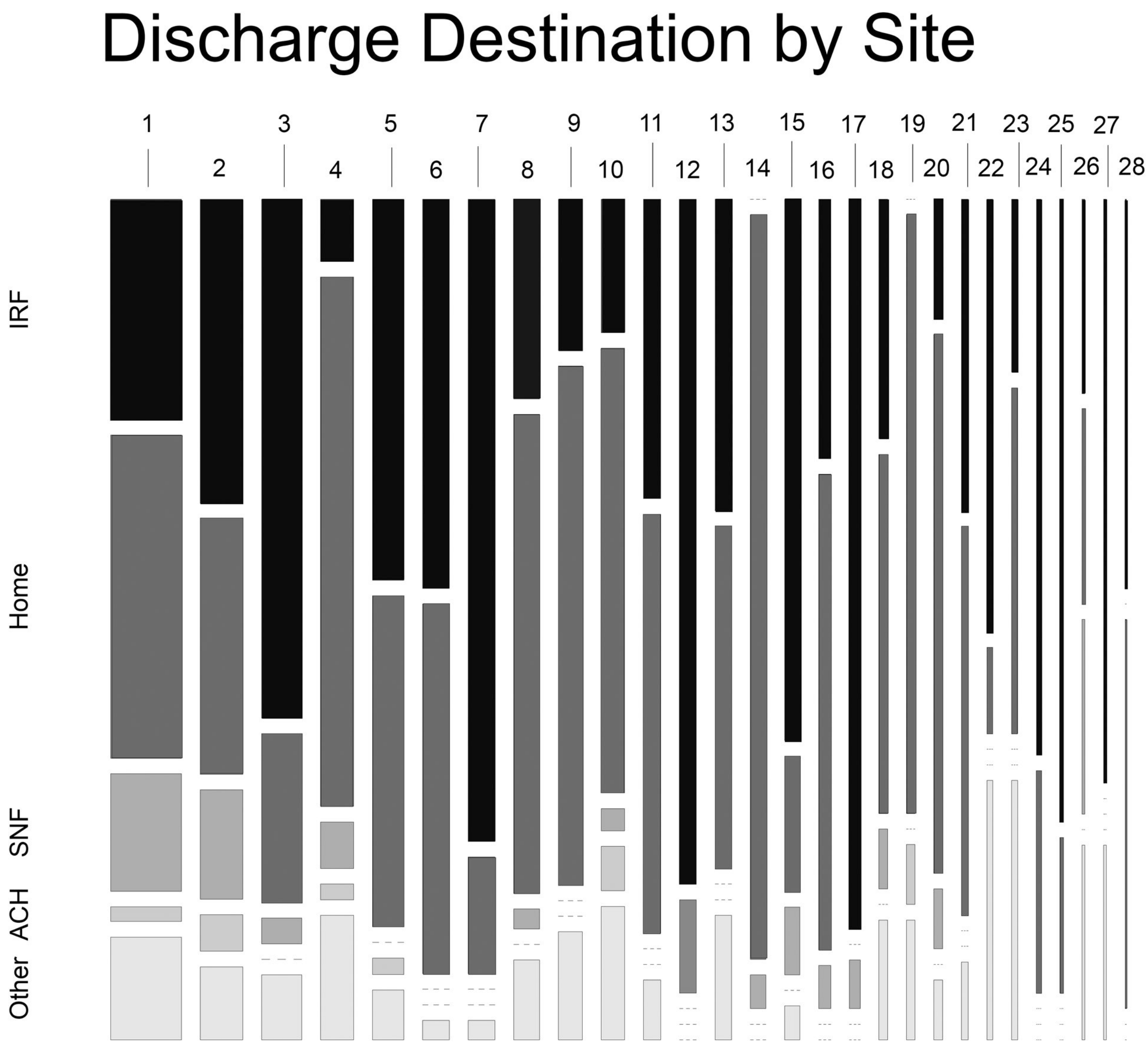

Figure 1.

Discharge Destination From Acute Stroke Admission According to Enrollment Site. Sites are numbered in order of number of enrollees, which is reflected in column width. IRF=Inpatient Rehabilitation Facility, SNF=Skilled Nursing Facility, ACH=Acute Care Hospital.

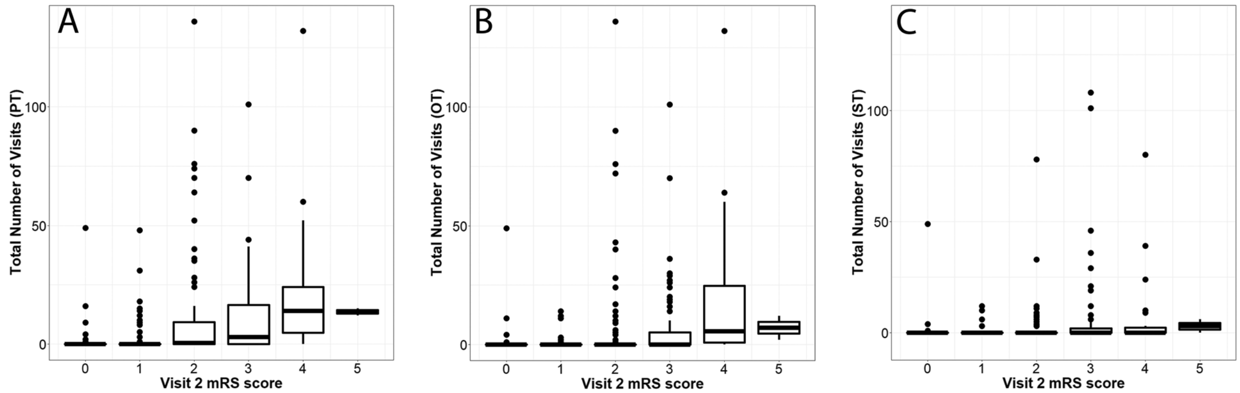

Figure 2.

Cumulative Rehabilitative Therapy from 3-Months to One Year Post-Stroke in Relation to 3-month mRS Score

Higher mRS (modified Rankin Scale) score, indicating greater disability, at 3-months post-stroke was associated with a larger dose of subsequent rehabilitation therapy. A. Physical therapy, B. Occupational therapy, and C. Speech therapy.

Table 1.

Summary of subject characteristics at Visit 2

n	**510**
Age (years)	62.3 ± 14.8
Gender	302 Male 207 Female 1 Other
Race	
American Indian or Alaska Native	5
Asian	28
Native Hawaiian or Pacific Islander	4
African-American or Black	79
White	355
More Than One Race	26
Unknown	13
Ethnicity	
Hispanic or Latino	67
Not Hispanic or Latino	439
Unknown	4
Education	
Not a High School Graduate	47
Completed High School	127
Some College	158
Completed Undergraduate Degree	89
Some Graduate Education	62
Completed Doctoral Degree	26
Declined to State	1
Stroke Type	
Ischemic	434
Hemorrhagic	76
Initial acute NIHSS score	4 [2–9], range 0–32
Antidepressant Use at Time of Enrollment	151
Discharge Destination	
Home	222
Inpatient Rehabilitation Facility	200
Skilled Nursing Facility	30
Other Acute Care Hospital	7
Other	51

These data were acquired during the acute stroke admission. Values are mean±SD or median [IQR]. SD = standard deviation, IQR = inter-quartile range

Table 2.

Cumulative Number of Therapy Sessions Reported by Subjects at Visits 2, 3, and 4

		Up to Visit 2	**Up to Visit 3**	**Up to Visit 4**
PT	Mean±SD	12.1±16.8	14.4±20.1	18.0+28.6
	Median	6	6	8
	Range	0–120	0–123	0–232
	Percent with no therapy	35.0	35.6	32.9
OT	Mean±SD	9.7+15.6	11.0+18.3	13.7+26.5
	Median	1	1	1.5
	Range	0–100	0–110	0–232
	Percent with no therapy	48.8	49.1	46.9
ST	Mean±SD	6.0+12.5	6.6+14.6	7.9+20.1
	Median	0	0	0
	Range	0–82	0–90	0–193
	Percent with no therapy	61.7	63.6	60.4

PT = Physical Therapy, OT = Occupational Therapy, ST = Speech Therapy, SD = standard deviation

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Table 3.

Relationships between Acute Stroke Features and Cumulative Rehabilitation Therapy

Predictor		Visit 2		Visit 3		Visit 4	
		Rate Ratio	p	Rate Ratio	p	Rate Ratio	p
Race	PT	--	NS	--	NS	--	NS
	OT	--	NS	--	NS	--	NS
	ST	0.274 *	0.047	--	NS	--	NS
Ethnicity	PT	0.533	0.028	--	NS	0.536	0.042
	OT	0.430	0.023	0.452	0.043	0.324	<0.01
	ST	--	NS	--	NS	--	NS
Initial NIHSS	PT	1.078	<0.01	1.075	<0.01	1.087	<0.01
	OT	1.093	<0.01	1.089	<0.01	1.109	<0.01
	ST	1.128	<0.01	1.135	<0.01	1.145	<0.01
Grip Strength	PT	0.428	<0.01	0.428	<0.01	0.410	<0.01
	OT	0.293	<0.01	0.317	<0.01	0.319	<0.01
	ST	0.269	<0.01	0.240	<0.01	0.225	<0.01
Aphasia	PT	--	NS	--	NS	--	NS
	OT	--	NS	--	NS	--	NS
	ST	1.483	0.025	1.555	0.019	1.632	<0.01
Neglect	PT	1.398	0.020	1.471	<0.01	1.592	<0.01
	OT	--	NS	1.488	0.028	1.689	<0.01
	ST	1.575	0.039	1.726	0.017	1.951	<0.01

P values are FDR-adjusted

* rate ratio for the comparison between subjects who identified as Asian and those who identified as White.

PT = Physical Therapy, OT = Occupational Therapy, ST = Speech Therapy, NS = not significant.

Table 4.

Relationships between Clinical Scores 3 Months After Stroke and Subsequent Rehabilitation Therapy

Assessment		**Visit 3**		**Visit 4**	
		Rate Ratio	**p**	**Rate Ratio**	**p**
Fugl-Meyer Upper Extremity	PT	0.956	<0.01	0.955	<0.01
	OT	0.937	<0.01	0.946	<0.01
	ST	0.933	<0.01	0.941	<0.01
mRS	PT	2.023	<0.01	2.049	<0.01
	OT	2.467	<0.01	2.321	<0.01
	ST	2.059	<0.01	2.052	<0.01
SIS-ADL	PT	0.974	<0.01	0.964	<0.01
	OT	0.968	<0.01	0.956	<0.01
	ST	0.973	0.013	0.971	<0.01

PT = Physical Therapy, OT = Occupational Therapy, ST = Speech Therapy, mRS = modified Rankin Scale, SIS ADL = Stroke Impact Scale Activities of Daily Living.