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Original Research

Association of Rate of Functional Recovery With Therapy Time and Content Among Adults With Acquired Brain Injuries in Inpatient Rehabilitation

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KEYWORDS
Brain injuries;
Electronic health records;
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Abstract *Objective:* To examine associations among the time and content of rehabilitation treatment with self-care and mobility functional gain rate for adults with acquired brain injury.
Design: Retrospective cohort study using electronic health record and administrative billing data.
Setting: Inpatient rehabilitation unit at a large, academic medical center.
Participants: Adults with primary diagnosis of stroke, traumatic brain injury, or nontraumatic brain injury admitted to the inpatient rehabilitation unit between 2012 and 2017 (N=799).
Interventions: Not applicable.

List of abbreviations: ABI, acquired brain injury; ADL, activities of daily living; CMS, Center for Medicare and Medicaid Services; CPT, current procedural terminology; EHR, electronic health record; FIM, Functional Independence Measure; IADL, instrumental activities of daily living; IRF, inpatient rehabilitation facility; LOS, length of stay; OT, occupational therapy; PT, physical therapy; SLP, speech-language pathology.

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Main Outcome Measures: Gain rate in self-care and mobility function, using the Functional Independence Measure. Hierarchical regression models were used to identify the contributions of baseline characteristics, units, and content of occupational therapy, physical therapy, and speech-language pathology treatment to functional gain rates.
Results: Median length of rehabilitation stay was 10 days (interquartile range, 8-13d). Patients received an mean of 10.62 units of therapy (SD, 2.05) daily. For self-care care gain rate, the best-fitting model accounted for 32% of the variance. Occupational therapy activities of daily living units were positively associated with gain rate. For mobility gain rate, the best-fitting model accounted for 37% of the variance. Higher amounts of physical therapy bed mobility training were inversely associated with mobility gain rate.
Conclusions: More activities of daily living in occupational therapy is associated with faster improvement on self-care function for adults with acquired brain injury, whereas more bed mobility in physical therapy was associated with slower improvement. A potential challenge with value-based payments is the alignment between clinically appropriate therapy activities and the metrics by which patient improvement are evaluated. There is a risk that therapists and facilities will prioritize activities that drive improvement on metrics and deemphasize other patient-centered goals.

The Centers for Medicare and Medicaid Services (CMS) in the United States is moving from volume to value-based purchasing of postacute care services. The purported goal of value-based payment models is to reward health care providers with incentive payments for quality of care, to support improved population health, and reduce costs.[1] In theory, value-based payments will ensure that patients receive the optimal amounts of rehabilitation services to produce positive functional outcomes. There is a crucial need for evidence to support decisions about the type and volume of therapy services each patient receives so that each facility can make informed rehabilitation care plan decisions that are likely to lead to functional improvements.[2]

In practice, value-based models transfer the risk for therapy costs and patient functional outcomes to providers.[3] The shift from volume to value-based purchasing is exemplified by the implementation of the Patient Driven Payment Model in skilled nursing facilities in the United States in October 2019.[4] Since its implementation, studies have shown that skilled nursing facilities have reduced the amount of therapy services provided to their clients and decreased the number of therapy staff employed.[5-8] It is unclear how these changes have impacted patient functional outcomes. CMS plans to implement a value-based purchasing approach for postacute care in inpatient rehabilitation facilities (IRFs) in the future.[9]

Currently, IRFs are required to provide 3 hours of rehabilitation services (occupational therapy [OT], physical therapy [PT], speech-language pathology [SLP]) for a minimum of 15 hours per week regardless of primary diagnosis.[10] Within each therapy service, there are a variety of codes, known as current procedural terminology (CPT) codes, that are used for billing purposes to reflect the types of treatment used. Current CMS policies for IRFs mandate that patients require at least OT and PT services, but do not specify how that therapy time should be allocated.[11]

Prior research suggests volume of services alone is insufficient for understanding patients' functional recovery.[12-15] Functional recovery for some health conditions, such as orthopedic surgery, shows little relationship with therapy time and may be better predicted by baseline function and length of stay (LOS).[16,17] The IRF service model, in which all patients receive the same volume of therapy, will not be sustainable in a value-based payment system; facilities will need to minimize low-value therapy activities.[18] There is currently limited evidence on which rehabilitation therapists and managers can base decisions about the time, frequency, and content of therapy to support optimal functional recovery.[2] In this policy environment, it is critical to be able to identify the type and amount of rehabilitation treatments that are associated with the greatest and fastest functional gain for patients receiving care in IRFs, while concurrently managing staffing needs and costs.

The purpose of this study is to examine the associations between the time and content of rehabilitation treatment with the rates of self-care and mobility functional recovery among adults with acquired brain injury (ABI) in a single IRF. CPT codes for OT, PT, and SLP services were used to represent therapy content. We hypothesized that OT volume and therapy content as noted in CPT codes would be positively associated with self-care gain rate, and that PT time and therapy content as noted in CPT codes would be positively associated with mobility gain rate.

Methods

This is a retrospective cohort study using electronic health record (EHR) and billing data from 2012 to 2017 from an inpatient rehabilitation unit at a large, urban academic medical center. This study was approved by the institutional review boards of Cedars Sinai and the University of Southern California. Informed consent was not applicable because data were collected as part of usual care.

Participants

Patient records were included for first admissions to the inpatient rehabilitation unit for a primary diagnosis of stroke, traumatic brain injury, or nontraumatic brain injury between 2011 and 2017. Participants were excluded from analysis if they did not have any billed therapy services (ie, admitted to unit but transferred or discharged before commencing treatment) or expired prior to discharge.[19] There was no minimum LOS for inclusion. All patients were evaluated with the Functional Independence Measure (FIM) at admission and discharge by the interdisciplinary team consisting of rehabilitation nursing, PT, OT, and SLP as part of usual care. There were no missing FIM data at either admission or discharge.

Data source

Data sources included archived EHRs and billing records. Demographic characteristics, diagnosis, case mix group, comorbidities, LOS, FIM at admission and discharge, and discharge location were extracted from the EHR and therapy volume (units) and content (CPT codes) from billing records. Data sets were merged based on matching patient identifier, date of birth, and date of admission before being deidentified for analysis. The data cleaning procedures were previously described which had been undertaken to ensure there were no duplicate records and that all variables satisfied conformance, completeness, and plausibility.[20,21]

Outcome measures

The FIM is well established as a valid and reliable measure for adults with ABIs.[22-25] Self-care and mobility gain rates: gain rates (functional change per day) were calculated by totaling the FIM items separately for self-care and mobility at admission and discharge; transforming scores to a Rasch-based equal interval scale (0-100)[26]; calculating the difference from admission to discharge; and dividing the difference by LOS days to reflect unit change per day.[13,16,17] The advantage of using the Rasch-transformed values is that they are based on a continuous, equal interval scale, in contrast with the ordinal raw scores.[27] Self-care items included eating, grooming, bathing, dressing upper body, dressing lower body, and toileting. Mobility items included tub transfer or shower transfer, bed-chair transfer, toilet transfer, walking or wheelchair, and climbing stairs.[26]

Independent variables

The primary independent variable of interest was volume of therapy by content type, as represented by CPT codes.[28] Volume of therapy services was calculated in billing units, which are approximately 15-minute increments. For example, 53-67 minutes of a particular service is billed as 4 units of that service. Total billed therapy units per person were calculated for each CPT code. Mean daily time per CPT code was calculated by dividing the respective totals by LOS days. Evaluation time was excluded. CPT codes by discipline are summarized in figure 1.

Data analysis

All analyses were conducted using Stata 18.[a] Descriptive statistics were used to characterize patient demographics by sex and distribution of therapy activities. Separate hierarchical regression models were used to evaluate the association of therapy time and content with gain rate separately for self-care and mobility, respectively. The order of entering covariates into each model was based on our hypotheses about which therapy content would be most associated with the outcome, after controlling for age and functional status at admission. Therefore, OT-related therapy content was added first in the self-care model, and PT-related therapy

Code Description	Example Treatment Activity
Occupational Therapy	
ADL/IADL	Dressing using compensatory strategies for hemiplegia
Therapeutic Activity	Placing dishes on a high shelf
Therapeutic Exercise	Active range of motion exercises for the shoulder
Physical Therapy	
Bed Mobility	Rolling from left to right
Gait Training	Walking with support for balance
Therapeutic Exercise	Leg extensions with a resistance band
Neuromuscular Re-education	Proprioceptive training using a balance board
Speech-Language Pathology	
Cognitive/Communication	Strategy training for memory support
Dysphagia	Swallowing exercises
Voice	Vocal exercises

ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living

Fig 1 Current procedural terminology codes by discipline with example treatment activities. ADL, activities of daily living; IADL, instrumental activities of daily living.

content was added first in the mobility model. Iterations accounted for additional therapies. Akaike information criterion and Bayes information criterion were calculated for each model iteration to support identification of the best-fitting model.[29]

Results

Out of 799 people in the initial cohort, 763 had billed therapy time and complete, valid records. Most of the samples were White older adults with Medicare fee-for-service insurance who were treated for a primary diagnosis of ABI-stroke. Participant characteristics are detailed in table 1. Table 2 summarizes self-care and mobility measures at admission and discharge.

Therapy time and content

Participants received a mean of 10.62 (SD, 2.05) units (equivalent to approximately 159min) of therapy per LOS day. Therapy content was distributed across OT activities of daily living (ADL)/instrumental activities of daily living (IADL) training (mean, 2.79units/LOS d; SD, 1.00); OT therapeutic activities (mean, 0.77units/LOS d; SD, 0.56); OT therapeutic exercise (mean, 0.44units/LOS d; SD, 0.46); PT bed mobility training (mean, 0.60units/LOS d; SD, 0.44); PT gait training (mean, 1.47units/LOS d; SD, 0.62); PT therapeutic exercise (mean, 0.83units/LOS d; SD, 0.54); PT neuromuscular reeducation (mean, 0.88units/LOS d; SD, 0.70); SLP cognitive/communication training (mean, 0.86units/LOS d; SD, 0.82); SLP dysphagia treatment (mean, 0.40units/LOS d; SD,

Table 1 Participant characteristics

Variable	Overall (N=799)	Male (n=412; 52%)	Female (n=387; 48%)
Mean age at admission ± SD (y)	69.68 ± 16.13	68.9 ± 16.3	70.5 ± 15.9
Race/ethnicity, n (%)			
White	604 (75.6%)	336 (81.6%)	268 (69.3%)
Black	113 (14.1%)	42 (10.2%)	71 (18.4%)
Asian	63 (7.9%)	26 (6.3%)	37 (9.6%)
Hispanic	19 (2.4%)	10 (2.4%)	9 (2.3%)
Marital status, n (%)			
Married	427 (53.4%)	277 (67.2%)	150 (38.8%)
Widowed	114 (14.3%)	24 (5.8%)	90 (23.3%)
Separated	6 (1.0%)	1 (.2%)	5 (1.3%)
Divorced	72 (9.1%)	21 (5.1%)	51 (13.2%)
Never married	180 (22.5%)	89 (21.6%)	91 (23.5%)
Primary diagnosis, n (%)			
Stroke	485 (60.7%)	232 (56.3%)	253 (65.4%)
Traumatic brain injury	88 (11.0%)	60 (14.6%)	28 (7.2%)
Nontraumatic brain injury	226 (28.3%)	120 (29.1%)	106 (27.4%)
Lived at home (before admission), n (%)	795 (99.5%)	411 (99.8%)	384 (99.2%)
Preadmission living with, n (%)			
Alone	166 (21.1%)	61 (15.0%)	105 (27.6%)
Family/relative	571 (72.6%)	327 (80.5%)	244 (64.0%)
Friends	14 (1.8%)	6 (1.5%)	8 (2.1%)
Attendant	21 (2.7%)	4 (1.0%)	17 (4.5%)
Other	15 (1.9%)	8 (2.0%)	7 (1.8%)
Discharge living situation, n (%)			
Home	356 (44.6%)	192 (46.7%)	164 (43.4%)
Skilled nursing facility	51 (7.1%)	24 (8.3%)	27 (7.0%)
Home with home health	329 (41.2%)	157 (38.2%)	172 (44.4%)
Other/not listed	62 (7.8%)	38 (9.2%)	24 (6.2%)
Discharge living with, n (%)			
Alone	20 (2.5%)	8 (1.9%)	12 (3.1%)
Family/relative	459 (57.4%)	247 (60.0%)	212 (54.8%)
Friends	12 (1.5%)	5 (1.2%)	7 (1.8%)
Attendant	42 (5.3%)	13 (3.1%)	29 (7.5%)
Other	19 (2.4%)	12 (2.9%)	7 (1.8%)
Unknown	247 (30.9%)	127 (30.8%)	120 (31.0%)
Insurance type, n (%)			
Medicare FFS	513 (64.2%)	251 (60.1%)	262 (67.7%)
Medicare Advantage	25 (3.1%)	11 (2.7%)	14 (3.6%)
Private	261 (32.7%)	150 (36.4%)	111 (28.7%)
Length of stay (d), median (IQR)	10 (8-13)	11 (9-14)	10 (7-11)

Abbreviations: FFS, fee for service; IQR, interquartile range.

Table 2 Self-care and mobility measures at admission and discharge.

Variable	Overall (n=763)	Male (n=387)	Female (n=376)
Self-care measure			
Admission	49.62 ± 8.77	50.23 ± 8.41	49.00 ± 9.09
Discharge	60.65 ± 8.89	60.69 ± 8.81	60.61 ± 8.99
Mobility measure			
Admission	44.56 ± 8.56	44.95 ± 8.84	44.16 ± 8.25
Discharge	57.35 ± 7.46	57.63 ± 7.34	57.06 ± 7.58

Data are reported as mean $\pm$ SD.

0.55); and SLP voice treatment (mean, 0.56units/LOS d; SD, 0.92).

Self-care gain per day

Hierarchical models for self-care gain per day are presented in table 3. The best-fitting model, which explained 32% of the variance in the outcome, included age and self-care function at admission, LOS days, OT ADL/IADL training, PT bed mobility training, and SLP dysphagia. Only OT ADL/IADL training was positively associated with self-care gain per day (eg, more OT ADL/IADL time was associated with faster per day improvement on self-care); all other variables were inversely associated with the outcome. Adding OT therapeutic activity units per day did not change the explained variance. OT therapeutic exercise was not significantly associated with self-care gain rate.

Mobility gain per day

Hierarchical models for mobility per day are presented in table 4. The best-fitting model, which explained 37% of the variance in the outcome, included age, sex, self-care function at admission, LOS days, PT bed mobility training, PT therapeutic exercise, and SLP dysphagia. All variables were inversely related to the outcome (eg, higher PT bed mobility training was associated with slower per day recovery of mobility function).

Discussion

This study used data from EHRs and administrative billing records from an inpatient rehabilitation unit to examine the association between the time and content of therapy and self-care and mobility functional outcomes for adults with ABI. Findings show that, after accounting for baseline age and function, more OT ADL/IADL training is associated with faster improvement in self-care function. This finding is likely attributable to good alignment between the activities included in OT ADL/IADL CPT code and self-care items on the FIM. Conversely, more time on PT bed mobility training is associated with slower improvement per day in both self-care and mobility function. This latter finding may reflect incongruence between time spent on treatments that are clinically warranted and the outcome metrics by which progress is evaluated. Specifically, time spent on bed mobility may be necessary to support functional improvement but may not produce gains on more challenging mobility items, such as walking and climbing stairs. The results reflect potential challenges of implementing a value-based payment model, as self-care and mobility metrics have implications for how therapy time and content in IRFs are distributed.

OT therapeutic exercise was not significantly associated with either self-care or mobility gain rate. Possible reasons include that (1) exercise was not of sufficient intensity to invoke change; (2) LOS was not sufficiently long to observe changes resulting from exercise; (3) exercise did not translate to gain in functional activities. This result is similar to prior studies that did not find a significant relationship between the proportion of therapy time dedicated to upper extremity exercise and independence with functional activities using the upper extremities.[30] Similarly, PT neuromuscular reeducation was not associated with either self-care or mobility gain rate. It is possible that these types of therapies had positive effects on other unmeasured outcomes, such as muscle strength and endurance, but did not produce measurable change in self-care or mobility function. Thus, a potential risk of value-based payments is that rehabilitation treatments will be focused on outcomes by which reimbursement is determined, possibly to the detriment of other patient-centered goals. Others have called for value-based payment models to integrate patients' perspectives as a means to understanding the degree to which rehabilitation care supports a safe return to community living.[31]

Value-based payment models utilize measures of quality and cost to determine payment for providers. This approach is intended to hold providers accountable for improving outcomes while also providing the right care at the right time in the right amount for the lowest cost.[32] Therapists and facilities need to consider the contributions of rehabilitation interventions to patient outcomes more broadly than the functional measures on which they typically focus on (ie, self-care, mobility). The best-fitting models explained 32% of the variation in self-care and 37% of the variation in mobility, suggesting that factors other than therapy services contribute to patient functional outcomes.

Study limitations

This observational study used data from a single-center academic medical center. Billing records (CPT codes) were used to characterize therapy content. Within each code, a variety of intervention approaches are possible. Some of the activities may not have been captured from a billing code if it did

Table 3 Hierarchical model for self-care gain per day outcome

Model	Variable Added to Model	Adjusted R2	AIC	BIC	Coefficient (SE) SC Measure ADM	Age at Admission	Sex (F)	LOS	OT ADL/IADL	OT Therapeutic Activity	OT Therapeutic Exercise	PT Bed Mobility	PT Gait Training	PT Therapeutic Exercise	PT NM Re-ed	SLP Cog	SLP Dys	SLP Voice
1	SC Measure at admission + age at admission + sex	0.06	2485	2503	-0.03 (0.01)*	-0.01 (0.00)†	−0.04 (0.09)											
2	LOS	0.27	2294	2317	−0.07 (0.01)*	−0.01 (0.00)*	−0.03 (0.08)	−0.13 (0.01)*										
3	OT ADL/IADL	0.27	2296	2323	−0.07 (0.01)*	−0.01 (0.00)*	−0.03 (0.08)	−0.13 (0.01)*	−0.00 (0.04)									
4	OT therapeutic activity	0.27	2296	2328	−0.08 (0.01)*	−0.01 (0.00)*	−0.01 (0.08)	−0.13 (0.01)*	0.01 (0.04)	0.11 (0.07)								
5	OT therapeutic exercise	0.27	2297	2334	−0.08 (0.01)*	−0.01 (0.00)*	−0.01 (0.08)	−0.13 (0.01)*	0.01 (0.04)	0.11 (0.07)	0.03 (0.09)							
6	PT bed mobility	0.31	2247	2289	−0.08 (0.01)*	−0.01 (0.00)*	−0.03 (0.08)	−0.11 (0.01)*	0.10 (0.04)‡	0.11 (0.08)	0.10 (0.09)	−0.73 (0.10)*						
7	PT gait training	0.31	2248	2294	−0.09 (0.01)*	−0.01 (0.00)*	−0.03 (0.08)	−0.12 (0.01)*	0.09 (0.04)‡	0.09 (0.07)	0.09 (0.09)	−0.73 (0.10)*	0.07 (0.06)					
8	PT therapeutic exercise	0.32	2246	2297	−0.08 (0.01)*	−0.01 (0.00)*	−0.03 (0.07)	−0.12 (0.01)*	0.10 (0.04)‡	0.09 (0.07)	0.12 (0.09)	−0.71 (0.10)*	0.09 (0.07)	−0.14 (0.07)				
9	PT neuromuscular reeducation	0.32	2248	2304	−0.08 (0.01)*	−0.01 (0.00)*	−0.03 (0.07)	−0.12 (0.01)*	0.10 (0.04)‡	0.10 (0.07)	0.12 (0.09)	−0.71 (0.10)*	0.09 (0.07)	−0.14 (0.08)	−0.01 (0.06)			
10	SLP cognitive-communication	0.32	2249	2309	−0.09 (0.01)*	−0.01 (0.00)†	−0.03 (0.08)	−0.12 (0.01)*	0.09 (0.04)‡	0.09 (0.07)	0.13 (0.09)	−0.71 (0.10)*	0.09 (0.07)	−0.14 (0.08)	−0.01 (0.06)	0.05 (0.05)		
11	SLP dysphagia	0.33	2239	2304	−0.09 (0.01)*	−0.01 (0.00)†	−0.05 (0.08)	−0.12 (0.01)*	0.10 (0.04)‡	0.09 (0.07)	0.10 (0.09)	−0.70 (0.10)*	0.06 (0.07)	−0.15 (0.08)	0.01 (0.06)	0.03 (0.05)	−0.25 (0.07)‡	
12	SLP voice	0.33	2240	2309	−0.09 (0.01)*	−0.01 (0.00)†	−0.06 (0.08)	−0.12 (0.01)*	0.10 (0.04)‡	0.09 (0.07)	0.09 (0.09)	−0.71 (0.10)*	0.06 (0.07)	−0.16 (0.08)	0.01 (0.06)	0.01 (0.05)	−0.25 (0.07)*	−0.04 (0.04)
13	Best-fitting model	0.32	2234	2266	−0.08 (0.01)*	−0.01 (0.00)†		−0.11 (0.01)*	0.08 (0.04)‡			−0.71 (0.10)*					−0.25 (0.07)*	

R2 is the coefficient of determination.

Abbreviations: Ac, activity; ADL, activities of daily living; ADM, admission; AIC, Akaike information criterion; BIC, Bayes information criterion; Cog, cognition; Dys, dysphagia; Ex: exercise; F, female; IADL, instrumental activities of daily living; LOS, length of stay; NM, neuromuscular; OT, occupational therapy; PT, physical therapy; Re-ed, reeducation; SC, self-care; SLP, speech-language pathology; Ther, therapeutic.

* $P \leq .001$.

† $P \leq .01$.

‡ $P \leq .05$.

Table 4 Hierarchical model for mobility gain per day outcome

Model	Variable Added to Model	Adjusted R2	AIC	BIC	Coefficient, (SE) Mobility measure at admission	Age at Admission	Sex	LOS	PT Bed Mobility	PT Gait	PT Ther Ex	PT NM Re-ed	OT ADL/IADL	OT Ther Ac	OT Ther Ex	SLP Cog	SLP Dys	SLP Voice
1	Mobility measure at admission + age at admission + sex	0.13	3493	3511	−0.10 (0.01)*	−0.02 (0.01)*	−0.35 (0.17)†											
2	LOS	0.32	3298	3322	−0.20 (0.01)*	−0.02 (0.00)*	−0.29 (0.15)	−0.26 (0.02)*										
3	PT bed mobility	0.36	3261	3289	−0.22 (0.01)*	−0.02 (0.00)‡	−0.29 (0.15)	−0.26 (0.02)*	−1.24 (0.20)*									
4	PT gait training	0.36	3263	3295	−0.23 (0.01)*	−0.02 (0.00)‡	−0.29 (0.15)	−0.25 (0.02)*	−1.25 (0.20)*	0.07 (0.13)								
5	PT therapeutic exercise	0.36	3261	3298	−0.22 (0.01)*	−0.01 (0.00)‡	−0.29 (0.15)†	−0.26 (0.02)*	−1.20 (0.20)*	0.11 (0.13)	−0.29 (0.14)							
6	PT neuromuscular reeducation	0.36	3261	3302	−0.22 (0.01)*	−0.02 (0.00)‡	−0.32 (0.15)†	−0.26 (0.02)*	−1.20 (0.20)*	0.12 (0.13)	−0.36 (0.15)†	−0.16 (0.12)						
7	OT ADL/IADL	0.36	3263	3309	−0.22 (0.01)*	−0.02 (0.00)‡	−0.31 (0.15)†	−0.26 (0.02)*	−1.20 (0.20)*	0.13 (0.13)	−0.36 (0.15)†	−0.16 (0.12)	−0.03 (0.08)					
8	OT therapeutic activity	0.36	3264	3309	−0.22 (0.01)*	−0.02 (0.00)‡	−0.30 (0.15)†	−0.26 (0.02)*	−1.20 (0.20)*	0.12 (0.13)	−0.37 (0.15)†	−0.18 (0.12)	−0.02 (0.08)	0.06 (0.14)				
9	OT therapeutic exercise	0.36	3266	3321	−0.23 (0.01)*	−0.02 (0.00)‡	−0.30 (0.15)†	−0.26 (0.02)*	−1.22 (0.20)*	0.10 (0.13)	−0.39 (0.15)†	−0.19 (0.12)	−0.01 (0.08)	0.08 (0.14)	0.16 (0.17)			
10	SLP cognitive-communication	0.36	3267	3327	−0.22 (0.01)*	−0.02 (0.00)‡	−0.30 (0.15)†	−0.26 (0.02)*	−1.22 (0.20)*	0.10 (0.13)	−0.39 (0.15)†	−0.19 (0.12)	0.00 (0.08)	0.09 (0.14)	0.15 (0.17)	−0.06 (0.09)		
11	SLP dysphagia	0.37	3259	3324	−0.23 (0.01)*	−0.02 (0.00)‡	−0.35 (0.15)†	−0.26 (0.02)*	−1.21 (0.20)*	0.07 (0.13)	−0.41 (0.15)†	−0.16 (0.12)	0.01 (0.08)	0.09 (0.14)	0.11 (0.17)	−0.11 (0.09)	−0.44 (0.14)‡	
12	SLP voice	0.37	3261	3330	−0.23 (0.01)*	−0.02 (0.00)‡	−0.36 (0.15)†	−0.26 (0.02)*	−1.21 (0.21)*	0.07 (0.13)	−0.41 (0.15)†	−0.16 (0.12)	0.01 (0.08)	0.09 (0.14)	0.10 (0.17)	−0.13 (0.10)	−0.45 (0.14)‡	−0.04 (0.09)
13	Best-fitting model	0.37	3250	3288	−0.22 (0.01)*	−0.01 (0.00)‡	−0.33 (0.15)†	−0.25 (0.02)*	−1.18 (0.20)*		−0.31 (0.14)†						−0.44 (0.14)‡	

R2 is the coefficient of determination.

Abbreviations: Ac; activity; ADL, activities of daily living; AIC, Akaike information criterion; BIC, Bayes information criterion; Cog, cognition; Dys, dysphagia; Ex, exercise; IADL, instrumental activities of daily living; LOS, length of stay; NM, neuromuscular; OT, occupational therapy; PT, physical therapy; Re-ed, reeducation; SLP, speech-language pathology; Ther, therapeutic.

* $P \leq .001$.

† $P \leq .05$.

‡ $P \leq .01$.

not meet the minimum threshold for a billing unit (<8 minutes). Data about treating therapists were not available, nor could we discern if the patients saw the same team of therapists consistently during their admission. There are other valid CPT codes for inpatient rehabilitation that did not appear in the data set. Although there are definitions for when each code should be used, it is possible that there was some variability in application and overlap between disciplines.

Other factors for which we did not have data, such as medical complications and comorbidities, may influence rehabilitation outcomes and rate of improvement. Nonetheless, this study offers useful insight into the distribution of therapy content as represented by CPT codes, and points to a potential misalignment between the quality metrics used to evaluate functional improvement and the types of rehabilitation treatments that are clinically appropriate for patients with ABIs, particularly in the mobility domain.

Future research

Future studies should examine site variation in use of CPT codes and associations with functional outcomes across multiple IRFs. Given the evidence to support the role of the therapeutic relationship in patient outcomes, the number of different rehabilitation providers a patient sees during a LOS and its association with functional outcomes should be studied. Qualitative methods can be used to investigate variation in the kinds of activities that occur within each CPT code and their alignment with functional items mandated by CMS in IRFs.

Value is driven by 2 main components: costs and patient outcomes. In adapting to value-based payment models, IRFs will need to address both. The most obvious way to cut costs is to reduce the volume of therapy services; this result has been observed in skilled nursing facilities after implementation of the Patient Driven Payment Model.[5-7] There is an opportunity for IRFs to find value by using their data to drive improved patient outcomes, thereby balancing the value equation and reducing low-value care.[18] The adoption of the learning health system approach across the United States offers the promise of turning practice data into actionable knowledge to improve outcomes.[33] Rehabilitation departments can contribute to the implementation of learning health systems by identifying value-generating practices.[34] Relying on cost-cutting to drive value could result in more aggressive patient screening to limit IRF admission for people who are likely to be discharged to somewhere other than the community (eg, skilled nursing facility or long-term acute care hospital), potentially exacerbating health disparities.

Conclusions

The transition to a value-based payment model in IRFs will shift risks of poor patient functional outcomes to rehabilitation therapists. Facilities will need to make decisions about costs and service delivery to produce optimal results and limit low-value care. This study showed that time spent in OT ADL/IADL training was associated with faster self-care gains for adults with ABI; however, in the value-based model, rehabilitation therapists will need to consider their contributions to patient outcomes more broadly, as well as other factors that impact functional improvement. In this changing policy context, rehabilitation teams have an opportunity to utilize their data to support informed decisions about what kinds of rehabilitation therapy drive improved patient outcomes, thus generating better value for patients and meeting facility goals.

Suppliers

a. Stata, version 18; StataCorp.

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Disclosure

The authors have no conflicts of interest to report.

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