The SCIR rehab project: treatment time spent in SCI rehabilitation Speech-language pathology treatment time during inpatient spinal cord injury rehabilitation: the SCIR rehab project

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Background/objective: Following spinal cord injury (SCI), speech-language pathologists (SLPs) perform assessments and provide treatment for swallowing, motor speech, voice, and cognitive–communication disorders that result from the SCI and/or co-occurring brain injuries. This paper describes the nature and distribution of speech-language pathology (SLP) activities delivered during inpatient SCI rehabilitation and discusses predictors (patient and injury characteristics) of the amount of time spent in specific SLP treatment activities.

Methods: Six rehabilitation centers enrolled 600 patients with traumatic SCI for an observational study of acute inpatient rehabilitation treatment (SCIR rehab). SLPs documented the details of assessment and treatment and time spent on each of a set of specific SLP activities during each patient encounter. Patterns of time use are described for all patients by neurological injury category. Ordinary least squares stepwise regression models are used to identify patient and injury characteristics predictive of treatment time in the specific SLP activities identified.

Results: SLP consults were requested for 40% of SCIR rehab patients. Fifty-seven percent of these patients received intense therapy (defined as more than five sessions during the rehabilitation stay); the remainder received primarily evaluation or less intense services (one to five sessions). The patients who participated in intense treatment received a mean total of 16.1 hours (range 2.5–105.2 hours, standard deviation (SD) 16.5, median 9.7 hours) of SLP; significant differences were seen in the amount of time spent in each activity among neurological injury groups. Cognitive–communication and swallowing therapy were the most common SLP activities. Patients with motor levels of injury at C1–C4 spent the highest percentage of their therapy time working on swallowing therapy while patients with low tetraplegia and paraplegia, and those classified as AIS D (regardless of motor level of injury) focused the greatest percentage of time on cognitive–communication work. Patient and injury characteristics explained a portion of the variation in time spent on cognitive–communication therapy but did not explain the variation in time spent on swallowing and other SLP treatment activities.

Conclusion: The need for swallowing and cognitive treatment by SLP is common during inpatient rehabilitation due to dysfunction resulting from use of artificial airways and feeding approaches, as well as secondary brain injuries. The large amount of variability seen in SLP treatment time, which is not explained well by patient and injury characteristics, sets the stage for future analyses to associate treatments with outcomes.

Keywords: Spinal cord injuries, traumatic, Tetraplegia, Paraplegia, Brain injury, traumatic, Rehabilitation, Health services research, Outcomes research, Speech-language pathology, Cognitive therapy, Communication disorders, Dysphagia, Practice-based evidence

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Introduction

Speech-language pathologists (SLPs) play an integral and active role on an inpatient rehabilitation spinal

cord injury (SCI) unit. They provide assessment and treatment in the areas of swallowing, motor speech, voice, and cognitive-communication functioning. Patients who sustain a cervical SCI may require dysphagia management secondary to known effects from cervical surgery.¹⁻⁴ Pathological voice disorders may be present after endotracheal intubation or from effects of cervical surgery,^{5,6} while artificial airways and mechanical ventilation may impact swallowing and voicing.^{1,4,7} Furthermore, traumatic brain injury (TBI) may be present, especially when the patient experienced an acceleration/deceleration injury. Macciocchi *et al.*^{8,9} found that 60% of study patients with traumatic SCI sustained a TBI, most of which were classified as mild. Depending on the extent of the TBI, areas such as memory, new learning, problem solving, and safety judgment may be affected and may impact the patient's rehabilitation process and discharge plans. As part of multidisciplinary treatment teams, SLPs treat patients with cognitive/communication disorders and provide recommendations for supervision levels, return to work, and school.

The SCIREhab project is a multi-center, 5-year investigation recording and analyzing the details of the SCI inpatient rehabilitation process for approximately 1400 patients and relating them to first-year post-injury outcomes. The study design and implementation of practice-based evidence (PBE) procedures in this project have been described previously.^{10,11} A speech-language pathology (SLP) taxonomy, which classifies the types of therapy provided during acute rehabilitation, was established for the project¹² and is embedded in a point-of-care (POC) documentation system that includes details of the main activities that are the focus of SLP therapy in the acute SCI rehabilitation setting. This paper aims at describing how SLP therapeutic time is spent during rehabilitation and how it differs for patients with different neurological levels and completeness of injury. Patient and injury characteristics associated with time spent on common SLP activities also are discussed.

Methods

The introductory paper¹³ to this SCIREhab series of articles describes the project's design, including use of PBE research methodology,^{10,11,14-16} participant inclusion criteria, data sources, and the analysis plan. We provide only a summary here. The SCIREhab team included representatives of all rehabilitation clinical disciplines (including SLP) from six inpatient rehabilitation facilities: Craig Hospital, Englewood, CO; Shepherd Center, Atlanta GA; Rehabilitation Institute of Chicago, Chicago, IL; Carolinas Rehabilitation, Charlotte, NC;

The Mount Sinai Medical Center, New York, NY; and the National Rehabilitation Hospital, Washington, DC. Institutional Review Board (IRB) approval was obtained at each center and patients who were 12 years of age or older, gave (or whose parent/guardian gave) informed consent, and were admitted to the facility's SCI unit for initial rehabilitation following traumatic SCI were enrolled. Patients with co-occurring severe brain injuries (Rancho Los Amigos Scale level IV or below) typically were admitted to the TBI rehabilitation unit and, thus, were not included in the SCIREhab data-gathering efforts. However, all patients admitted to the SCI rehabilitation unit, regardless of severity of a brain injury, were included.

Patient/injury and clinician data

Trained data abstractors collected patient and injury data from patient medical records. The International Standards of Neurological Classification of SCI (ISNCSCI) and its American Spinal Injury Association Impairment Scale (AIS)¹⁷ were used to describe the neurological level and completeness of injury; patients were placed into one of four neurological injury groups. Patients with AIS grade D were grouped together regardless of motor injury level. Patients with AIS classifications of A, B, and C were grouped together and separated by neurological level to create the remaining three categories: high tetraplegia (C1-C4), low tetraplegia (C5-C8), and paraplegia (T1 and below). These injury categories were selected because they were each large enough for analysis and created groupings thought to have relatively homogenous functional ability within groups and clear differences between the groups. The Comprehensive Severity Index (CSI[®]) was used to score the extent of deviation from normal each of a patient's complications and comorbidities was at the time of rehabilitation admission and over time within the center.¹⁸⁻²² The higher the patient's CSI score, the more deviant from normal ('the sicker') the patient was. The Functional Independence Measure (FIM[®]) was used to describe a patient's independence with specific motor and cognitive abilities at rehabilitation admission and discharge.^{23,24} SLPs who documented treatment data for the SCIREhab project completed a clinician profile that included their years of SCI rehabilitation experience at the start of the project.

SLP treatment data

SLPs at each SCIREhab project site entered details about each SLP session for each study patient into a handheld personal digital assistant (PDA; Hewlett Packard PDA hx2490b, Palo Alto, CA) containing a

modular custom application of the SCIREhab POC documentation system, which incorporates the SLP taxonomy activities (PointSync Pro version 2.0, MobileDataforce, Boise, ID, USA).

This taxonomy has been described in detail previously¹² and includes activities commonly employed in a SCI rehabilitation setting: initial assessment, cognitive-communication treatment (e.g. for attention, processing speed, and memory), swallowing therapy (e.g. pharyngeal strengthening exercises, use of neuromuscular electrical stimulation), communication treatment, motor speech and/or voice therapy (for patients with or without a tracheostomy and/or ventilator), and patient-family education. In addition, the time that SLPs spent in interdisciplinary conferences on the patient's behalf is included.

Each therapist was trained on use of the documentation system and tested quarterly to ensure accurate and consistent documentation; daily entries were compared by the local SCIREhab coordinator with patient schedules or daily therapy records to ensure that all sessions were included in the SLP POC documentation.¹⁰ Entered into the PDA were the date/time of each session, the number of minutes spent on intervention activities performed, and activity-specific details. Activity minutes were combined to equal the approximate duration of the full session.

Data analysis

Patients were stratified into three groups to reflect whether SLP services were directed primarily toward assessment (one to five SLP sessions during rehabilitation), toward more intensive SLP treatment (more than five SLP sessions during rehabilitation), or no SLP intervention.

Time spent in SLP treatment overall and in specific SLP activities was quantified by examining the total number of hours spent during the entire rehabilitation stay. This approach differs from that used by other clinical disciplines in the SCIREhab study; they used a calculated mean number of minutes per week as the primary measure of treatment intensity. Using mean minutes per week helps remove the influence of rehabilitation length of stay (LOS) when defining intensity of services. However, it is common for patients to be discharged from speech therapy after achievement of treatment goals prior to being discharged from the rehabilitation facility. Thus, because of truncated SLP service, the authors believe that using total hours of SLP treatments during the rehabilitation stay provides a more accurate reflection of the intensity of time spent during the period in which SLP services actually were provided.

Contingency tables/chi-square tests and analysis of variance were used to test differences across injury groups for categorical and continuous variables, respectively ($P < 0.05$ was considered statistically significant).

Patient and injury characteristics associated with total time spent on SLP activities were examined using ordinary least squares stepwise regression models. The strength of each model is determined by the R^2 value, which indicates the amount of variation explained by the significant predictor variables jointly. Type II semi-partial correlation coefficients allow for estimation of the unique contribution of each predictor variable.^{25,26} The parameter estimates indicate the direction and strength of the association between each independent variable with the dependent variable. The predictor variables used included gender, marital status, racial/ethnic group, traumatic SCI etiology, body mass index (BMI), English-speaking status, third-party payer, pre-injury occupational status, severity of illness (CSI) score, age at the time of injury, admission FIM motor and cognitive subscale scores, experience level of the clinician, and neurological injury group. The only models reported here are for SLP activities in which at least 70% of patients in each group (one to five sessions or more than five sessions) participated and that had an R^2 value >0.20 .

Results

Six-hundred patients with traumatic SCI were enrolled in the SCIREhab project during the first year of data collection at the six rehabilitation study centers. Details of patient demographic and injury characteristics are presented for the sample as a whole and for each of the four injury groups separately in the first article in this SCIREhab series¹³ (Table 1). The sample population was 81% male, 65% white (22% black), 38% married, mostly not obese (82% had a BMI of <30 , and 65% were employed at the time of injury. The mean age was 37.2 (standard deviation (SD) 16.6). Vehicular crashes were the most common cause of injury (49%), falls were the next most common (23%), followed by etiologies of sports (12%) and violence (11%); the remaining 5% were classified as other. The mean rehabilitation LOS was 55 days (range 2–259 days, SD 37, median 43). The mean total FIM score at admission was 53 (SD 15), with a mean motor subscale score of 24 (SD 12) and a cognitive subscale score of 29 (SD 6). A mean of 32 days (SD 28) had elapsed from the time of injury to the time of rehabilitation admission (median 24 days, range 2–236).

SLP consults were requested for 237 (40%) of SCIREhab patients. A minority of patients (15% of the

Table 1 SLP activities: percent patients receiving each type of service and mean total hours (standard deviation) over the entire stay, separately for those receiving primarily assessment services (top panel) and those receiving intensive treatment (bottom panel), by neurological category

SLP activities for patients with 1–5 SLP sessions	All patients with 1–5 sessions (<i>n</i> = 103)	C1–C4 AIS A, B, C (<i>n</i> = 21)	C5–C8 AIS A, B, C (<i>n</i> = 38)	Para AIS A, B, C (<i>n</i> = 25)	AIS D (<i>n</i> = 19)
Total hours (SD)	1.3 (0.9)	1.3 (0.9)	1.3 (0.7)	1.4 (1.1)	1.4 (0.9)
Assessment (initial) (%)	77	67	82	72	84
Total hours (SD)	0.6 (0.5)	0.4 (0.4)	0.6 (0.5)	0.5 (0.4)	0.7 (0.5)
Cognitive–communication treatment (%)	30	19	24	48	32
Total hours (SD)*	0.3 (0.6)	0.1 (0.3)	0.2 (0.3)	0.6 (1.0)	0.3 (0.4)
Communication treatment (%)	3	0	0	8	5
Total hours (SD)	<0.1 (0.1)	0.0 (0.0)	0.0 (0.0)	<0.1 (0.1)	0.1 (0.2)
Education (%)	41	48	47	20	47
Total hours (SD)*	0.1 (0.2)	0.2 (0.2)	0.2 (0.2)	<0.1 (0.1)	0.2 (0.2)
Interdisciplinary conferencing (%)	18	14	18	20	21
Total hours (SD)	0.1 (0.3)	0.2 (0.5)	0.1 (0.3)	0.1 (0.2)	0.1 (0.4)
Speech therapy for motor/voice disorders (%)	8	19	8	4	0
Total hours (SD)*	0.1 (0.3)	0.2 (0.6)	0.1 (0.3)	<0.1 (0.1)	0.0 (0.0)
Speech therapy for tracheostomy and ventilators (%)	8	14	13	0	0
Total hours (SD)	<0.1 (0.2)	0.1 (0.4)	0.1 (0.2)	0.0 (0.0)	0.0 (0.0)
Swallowing therapy (%)	21	33	21	12	21
Total hours (SD)	0.1 (0.4)	0.2 (0.4)	0.1 (0.4)	0.1 (0.3)	0.1 (0.4)
SLP activities for patients with >5 SLP sessions	Full SCIRehab sample (<i>n</i> = 134)	C1–C4 AIS A, B, C (<i>n</i> = 52)	C5–C8 AIS A, B, C (<i>n</i> = 30)	Para AIS A, B, C (<i>n</i> = 33)	AIS D (<i>n</i> = 19)
Total hours (SD)	16.1 (16.5)	19.7 (21.0)	12.4 (9.7)	16.0 (14.3)	12.5 (13.4)
Assessment (initial) (%)	78	85	70	67	89
Total hours (SD)	1.8 (2.3)	2.1 (2.6)	1.3 (1.7)	1.8 (2.3)	1.6 (2.3)
Cognitive–communication treatment (%)	69	52	70	82	89
Total hours (SD)	5.4 (8.3)	5.3 (10.2)	5.1 (7.6)	6.2 (6.3)	5.0 (7.1)
Communication treatment (%)	27	25	17	36	32
Total hours (SD)	0.9 (4.1)	1.0 (4.6)	0.3 (0.7)	1.5 (5.6)	0.6 (1.5)
Patient/family education (%)	78	75	77	79	84
Total hours (SD)	0.6 (0.7)	0.7 (0.8)	0.5 (0.5)	0.6 (0.6)	0.7 (0.8)
Interdisciplinary conferencing (%)	100	100	100	100	100
Total hours (SD)	2.3 (2.0)	2.5 (2.0)	1.9 (1.6)	2.3 (1.9)	2.1 (2.6)
Speech therapy for motor/voice disorders (%)	19	21	30	12	11
Total hours (SD)	0.3 (1.0)	0.3 (1.0)	0.5 (1.0)	0.3 (1.2)	<0.1 (0.2)
Speech therapy for tracheostomy and ventilators (%)	23	38	23	12	0
Total hours (SD)*	0.9 (2.4)	1.6 (3.0)	0.6 (1.5)	0.5 (2.6)	0.0 (0.0)
Swallowing (%)	48	67	57	21	26
Total hours (SD)	3.9 (7.9)	6.3 (9.1)	2.2 (3.6)	2.7 (9.1)	2.4 (5.6)

*Statistically significant differences in time spent (mean hours) among neurological injury groups when looking at time spent for all patients in the treatment intensity group (one to five or more than five SLP sessions during rehabilitation).

600 patients) had a brain injury diagnosis (ICD-9 code) on admission but did not receive SLP services. The 237 patients were stratified into two groups to reflect intensity of SLP services (one to five SLP sessions during rehabilitation and more than five SLP sessions). There were 103 (17% of 600) patients who received only one to five SLP sessions during their entire rehabilitation period and, thus, were considered as receiving primarily evaluation services. Of these 103 patients, 27% had a brain injury diagnosis. They received a mean of 1.3 hours (range 0.2–4.1 hours, SD 0.9, median 1 hour) of SLP treatment during rehabilitation. The other 134 patients (22%), of whom 43% had a TBI diagnostic code, participated in more than five SLP sessions and were considered to have intensive treatment; they received a mean total of 16.1 hours (range 2.5–105.2 hours, SD 16.5, median 9.7 hours) of SLP. The total hours of SLP activities, over the entire rehabilitation stay, for the two treatment groups (evaluation (one to five sessions) vs. intense treatment (more than five sessions)) are shown in Table 1 for the entire sample and for the four neurological injury groups separately. Significant differences in the amount of time spent on cognitive–communication work and on speech treatments for patients with a tracheostomy

or on a ventilator were seen among the neurological injury group categorizations for patients who received one to five SLP sessions during rehabilitation; however, there were no patients in the AIS D group with time documented for the SLP activity of speech for tracheostomy and ventilator (Table 1). Significant differences among injury groups also were seen in the amount of time spent on speech interventions for tracheostomy and ventilator for patients who received more than five SLP sessions; again, no patients in the AIS D had any time documented for the SLP activity of speech for tracheostomy and ventilator.

Fig. 1 depicts the substantial variation in total hours spent within each SLP activity for patients who received more than five SLP sessions, including the two most common activities of cognitive–communication treatment and swallowing therapy. For cognitive–communication treatment, the interquartile range (IQR) was 0–7 hours (median 3), and for swallowing therapy the IQR was 0–4 hours (median 0), indicating that more than half of the patients did not participate in swallowing activities. Most swallowing work was done with patients in the C1–C4 ABC injury group where the IQR was 4–25 (median 11).

Figure 1 Variation in time spent (total hours over entire admission) on SLP activities – 134 patients with more than five SLP sessions.

Notes: †median = 0; *less than 25% of sample, all above 75th percentile.

Fig. 2 displays the percentage of patients among those who participated in more than five SLP sessions who received each SLP activity and the mean number of minutes over the entire stay spent on each activity; the mean is calculated for these patients who received at least one ‘dose’ of each treatment only. The mean number of minutes over the entire stay, instead of hours, is displayed on the figure so that visualization of activities with less time spent is clearer. For example, 69% of the 134 patients received cognitive–communication treatment and these patients spent a mean of 495 minutes (8.3 hours) working on cognitive–communication impairments (compared to the mean of 5.4 hours for the full group of 134 patients). A similar pattern is seen for swallowing therapy: only 48% of patients who had more than five SLP sessions worked on swallowing, but these patients spent almost 500 minutes (mean) on this activity compared to 234 minutes (3.9 hours) for the full group of 134 patients. The majority of swallowing therapy was done with patients in the two tetraplegia groups.

Some variation that was seen in total time spent on SLP activities can be attributed to patient and injury characteristics, as shown in Table 2. Regression models are presented only if more than 70% of patients participate in the SLP activity (within treatment intensity groups) and the regression model had sufficient explanatory power ($R^2 < 0.20$, which means that at least 20% of the variation

was explained). The parameter estimate indicates the strength and direction (how much (more or less) time was spent (total hours) of the association between each independent (predictor) variable with the dependent variable. The type II semi-partial R^2 value signifies the unique contribution that the predictor variable adds to the total R^2 for the model after controlling for other variables in the model. For patients who received only one to five SLP sessions during the rehabilitation stay, the only model that had a sufficient percentage of patients participate ($>70\%$) and sufficient explanatory power ($R^2 > 0.20$) was for cognition–communication treatment. This regression model explained 23% of the variation in total time spent ($R^2 = 0.23$). The parameter estimate for injury group: Para ABC (independent variable) was 0.41, which indicated that patients in this group received an average of nearly three-quarters of an hour more of cognitive–communication training compared to patients in the other injury groups and the semi-partial R^2 indicated that this variable contributed 8% of the total R^2 . Higher admission cognitive FIM score and higher severity of illness score were associated with less time in cognitive–communication treatment (negative parameter estimate) and violence as the etiology of injury (as compared to other etiologies) was associated with more time in treatment (positive parameter estimate).

For patients who received more intensive SLP treatment (five or more sessions during rehabilitation),

Figure 2 SLP activities: percent of 134 patients with more than five SLP sessions receiving each of eight different treatments and mean total minutes for those receiving each.

Table 2 Patient and injury characteristics associated with time (total hours) in SLP activities*,†

	Cognitive–communication treatment (cases with 1–5 sessions, <i>n</i> = 103)		Assessment (initial) (cases with >5 sessions, <i>n</i> = 134)		Patient/family education (cases with >5 sessions, <i>n</i> = 134)		Swallowing (cases with >5 sessions, <i>n</i> = 134)	
Total <i>R</i> ²	0.23		0.44		0.27		0.24	
Independent variables	Parameter estimate	Type II semi-partial <i>R</i> ²	Parameter estimate	Type II semi-partial <i>R</i> ²	Parameter estimate	Type II semi-partial <i>R</i> ²	Parameter estimate	Type II semi-partial <i>R</i> ²
Gender – male			–0.75	0.02				
Race – white							2.13	0.07
Severity of illness score (CSI)	–0.01	0.06	0.02	0.15	0.01	0.20		
Admission FIM motor score							–0.10	0.06
Admission FIM cognitive score	–0.04	0.08			0.02	0.05		
Injury group: AIS D					0.41	0.04		
Injury group: paraplegia ABC	0.41	0.08						
Ventilator use at rehabilitation admission			1.44	0.05				
Clinician experience			–0.08	0.02	0.03	0.03	0.24	0.08
Payer – private							–1.83	0.05
Traumatic etiology – violence	0.50	0.04						
Injury – work related					0.36	0.02		

*Activities were included only if total *R*² > 0.20 and more than 70% of patients in each intensity group (1–5 or >5 sessions) participated.

†Independent variables allowed into models: age at injury, male, married, race – white, race – black, race – Hispanic, race – other, admission FIM motor score, admission FIM cognitive score, severity of illness score (CSI), injury group: C1–C4 ABC, injury group: C5–C8 ABC, injury group: Para ABC, injury group: AIS D, clinician experience, traumatic etiology – vehicular, traumatic etiology – violence, traumatic etiology – falls, traumatic etiology – sports, traumatic etiology – medical/surgical complication, traumatic etiology – other, work-related injury, number of days from trauma to rehabilitation admission, BMI >40, BMI 30–40, BMI <30, language – English, language – no English, language – English sufficient for understanding, payer – Medicare, payer – workers' compensation, payer – private, payer – Medicaid, employment status at time of injury – employed, employment status at time of injury – student, employment status at time of injury – retired, employment status at time of injury – unemployed, employment status at time of injury – other, ventilator use on rehabilitation admission.

patient, injury, and clinician characteristics explained 24–44% of the variation on three SLP activities (see Table 2). The model for time spent on initial assessment shows that the combinations of these characteristics explained 44% of the variation in time spent on initial assessment; the severity of illness score explained most of this (semi-partial *R*² = 0.15, which means the CSI score accounted for 15% of the total 44% of explained variance). Ventilator use on rehabilitation admission was also associated with more time spent on initial assessment (positive parameter estimate).

The regression model for swallowing shows that 24% of the variation in time (*R*² = 0.24) is explained by several patient, injury, and clinician characteristics. Patients with higher motor FIM subscale score and those who had private payers spent less time on swallowing work (negative parameter estimates). Caucasian patients and patients who received treatment by clinicians with more SCI rehabilitation experience spent

more time on swallowing work (positive parameter estimates). Patient, injury, and clinician characteristics explained 27% of the variation in time spent by SLPs providing education to patients/families and, similar to time spent on assessment, the strongest predictor variable was the severity of illness score (it explained 20% of the total variation).

Discussion

Across the six centers involved in this study, patients with a severe brain injury (who also had an SCI) would likely be admitted to the brain injury rehabilitation unit (and thus were not included in this study). It is curious, however, that 15% of patients who were enrolled had an ICD-9 code for an acute brain injury but received no SLP services. This may be a reflection of rapid resolution of cognitive or communicative difficulties prior to the start of rehabilitation, the subtle nature of many of the effects of TBI, or

the diversity of effects of TBI beyond cognition and communication.

SLP services

All patients who receive SLP treatment would be expected to have an initial assessment; however, some study patients had no time documented for assessment. This may be due to initial assessments being conducted at the acute care level of hospitalization before the patient's transfer to the rehabilitation level of care within a facility. Oftentimes, SLPs will use this initial acute care assessment rather than repeating the assessment after transfer to rehabilitation. SCIRehab documentation included only those activities performed during the rehabilitation period and, thus, some initial assessments were not included.

The 103 patients who received one to five SLP sessions during rehabilitation may have been referred for an assessment and required no or limited treatment to achieve goals. For example, a referral for a cognitive/communication assessment may have been made and if the patient's skills were determined to be within normal parameters, continued SLP treatment would not be indicated. Upgrades in diet consistency, which can be completed in a single or a few interactions, are an example of why some patients with SCI may have had limited interactions with their SLP.

Swallowing and cognitive-communication were the two deficit areas that were addressed most often with patients who received more than five SLP sessions during rehabilitation, across the four neurological injury groups. A large percentage of patients (67%) with high tetraplegia who received more than five SLP sessions received treatment for swallowing and, for this group of patients, more time was spent on swallowing treatment (6.3 hours) than on cognitive therapy (5.3 hours). Our findings regarding the time spent on swallowing are consistent with evidence in the literature supporting the need for swallowing, or dysphagia-related, interventions. The incidence of dysphagia following anterior cervical decompression fusion has been found to be 55% on admission to rehabilitation hospitals.²⁷ This may be due to damage or insult to the vagus nerve (the recurrent laryngeal nerve) and/or distension or soft tissue swelling, which can be associated with the surgery. Tervonen *et al.*²⁸ reported that 69% of patients with anterior cervical surgeries had dysphagia immediately post-operatively (within the first week); however, after 3 months, most dysphagia had resolved. Several issues may contribute to SLPs spending more time evaluating and treating swallowing deficits than cognitive-communication problems. For patients who

arrive in rehabilitation with a nasogastric or orogastric tube used for enteral feeding or for patients who are receiving nothing by mouth, SLPs assess swallowing capabilities and provide recommendations for the safe return to oral intake or for a more permanent form of supplemental feeding, e.g. a percutaneous endoscopic gastrostomy tube. If the patient is ventilator dependent, the patient must learn to accommodate the timing of ventilator cycles and/or settings (pressure, rate of respiration, etc.) when swallowing.

Patients with high tetraplegia, who may also have concomitant brain injuries, have greater physical assistance needs than patients with lower levels of injury and those with TBI may benefit from cognitive training that helps them express their care needs to others. During early phases of rehabilitation, caregivers and/or the rehabilitation staff assume responsibility for providing personal care needs and for ensuring that the patient participates in rehabilitation therapies. As patients progress to more active participation in rehabilitation and directing their care, the need for cognitive retraining may become more evident and SLPs work with the patient on activity initiation, organization, time management, and other cognitive skills. If a patient is unable to utilize memory compensatory strategies or devices such as a memory notebook independently, speech therapists may focus on other compensatory strategies such as providing technology training to access and utilize computers or smart phones or having the family, caregiver, or rehabilitation staff provide reminders to the patient. Other examples of cognitive retraining include teaching the patient to direct caregivers in transfer techniques and the steps to activate a sip and puff drive mechanism on a power wheelchair or managing topographical orientation deficits in wheelchair navigation.

For patients with low tetraplegia (C5–C8), the primary focus of SLP treatment was on cognitive-communication work rather than on swallowing treatment as these patients experience less (or no) dysphagia. SCIRehab patients with low tetraplegia received an average of 5.1 hours of cognitive treatment. Treatment hours ranged from 0 to 29 hours (SD 7.6, median 1.6 hours), indicating that some patients' cognitive impairments may have been more severe or may have benefitted from more therapy in order for them to return to premorbid activities.

Predicting time spent on SLP activities

Multivariate regression analyses (for SLP activities that had R^2 values over 0.2 using the potential predictors used here) suggest that SLPs spend more time assessing

and providing education to patients with higher severity of illness (CSI) scores. The severity of a patient's TBI, along with other complications and comorbidities, is included in the CSI score; these patients require more complex assessment/evaluation and, along with their families, require more intensive education about speech challenges, swallowing techniques, cognition—communication re-training, and communication techniques. It makes sense that patients with higher admission FIM *motor* subscale scores (who have increased levels of motor control) are less likely to require swallowing treatment; swallowing deficits are far more prevalent among patients with high-level SCI. More SLP assessment time is devoted to patients who are ventilator dependent and have higher severity of illness scores. The additional time is needed to work through communication challenges associated with ventilator use and/or to accommodate more complex medical issues. However, when it comes to brief SLP intervention (one to five sessions), understanding associations between treatment time and patient or injury characteristics becomes more challenging and may require further investigation.

Interestingly, the experience level of clinicians is associated with time spent on assessment, education, and swallowing treatment for patients receiving more intense treatment (more than five SLP sessions during rehabilitation). Clinicians with more experience may have developed skills that allow them to spend less time assessing patient needs and more time providing education to patient/families and providing swallowing treatments.

We conducted regression analyses to examine patient and injury characteristics associated with time spent in specific activities. Our goal was not to compare one center to another and, thus, center identity was not entered into these models. However, we acknowledge that additional center differences, which may not be reflected in patient, injury, or clinician characteristics, may influence the amount of time spent on delivery of SLP treatment, and the nature of specific activities delivered in that time. When we allowed center identity (dummy coded) to enter the regression models reported here (time spent on cognitive—communication treatment for patients with one to five SLP sessions and for initial assessment, patient/family education, and swallowing treatment for patients with more than five SLP sessions), the explanatory power of the models increased only slightly. For patients who received more than five sessions, center effects added 4–14% to the explained variation of time spent. This minimal increase in explaining time spent on SLP work suggests that focusing on

patient, injury, and clinician characteristics is most helpful in explaining how time is spent on SLP activities, that center effects strengthen the explanatory power somewhat, and that the significant variation in time spent on SLP activities should prove useful in the eventual effort to correlate interventions with key patient outcomes.

Study limitations

The six SCIREhab sites were selected to participate based on their willingness, geographic diversity, and expertise in the treatment of patients with SCI, and offer variation in setting, care delivery patterns, and patient clinical and demographic characteristics. However, they are not a probability sample of the rehabilitation facilities that provide care for patients with SCI in the United States, and time reported overall or on specific activities may not be generalizable to all rehabilitation centers.

The SCIREhab project team strove for consistency in stratification of patients into four neurological injury groups for this series of articles; the groups were based first on AIS classification and then on neurological level of injury. However, for impairments of speech function, level of injury rather than AIS classification is more influential in determining the need for SLP intervention. Thus, some data for patients in the AIS D group may be difficult to interpret because their motor level of injury was not included in the data set analyzed here.

Conclusion

SLP is a consult service that was used for 40% of patients with traumatic SCI treated on specialized SCI units. The most common services provided were diagnosis and treatment of swallowing and of cognitive/communication disorders, which address common areas of dysfunction resulting from the use of artificial airways and feeding approaches, as well as brain injuries. Patients with high tetraplegia spent about 32% of SLP time on swallowing and 27% on cognitive—communication therapy, while patients with low tetraplegia, paraplegia, and AIS D spent approximately 40% of their SLP time on cognitive—communication work. The large amount of variability seen in SLP treatment time, which is not explained well by patient and injury characteristics, sets the stage for future analyses to associate treatments with outcomes.

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