Differences in Rehabilitation Services and Outcomes Among Stroke Patients Cared for in Veterans Hospitals

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Objective. To examine the relationship of services for post-acute care (PAC) to stroke patient outcomes.

Data Sources/Study Setting. Veterans Health Administration (VHA) hospitals from two facility-level surveys and extant data files.

Study Design. Cross-sectional study of veterans hospitalized with acute stroke during the period June 1995 through May 1996 in one of 182 geographically distinct locations within the VHA. Study variables included (1) a typological classification of hospitals according to the level of PAC; (2) a taxonomy of rehabilitation characteristics, including personnel, physical facilities, coordination of care, and hospital characteristics; and (3) patient outcomes (discharge destination, length of stay).

Data Collection/Extraction Methods. Data were collected from two mailed surveys and extant data files. Rehabilitation variables were identified for the study in conjunction with a panel of expert rehabilitation researchers and clinicians, using an a priori model for measuring rehabilitation characteristics. Two sets of variables were derived to categorize these rehabilitation characteristics: (1) a rehabilitation typology, classifying the VA hospitals according to the continuum of PAC settings in the facility, and (2) a rehabilitation taxonomy that used an empirical approach to derive a list of key rehabilitation characteristics.

Principal Findings. Twenty-seven percent of veterans with acute stroke were cared for in VA hospitals with neither a geriatric nor a rehabilitation unit, and 50 percent were cared for in hospitals without a rehabilitation unit. Hospitals with rehabilitation units had the greatest sophistication, and those with geriatric units had intermediate sophistication in rehabilitation organization and resources. Statistically significant differences were found in outcomes for stroke patients cared for in hospitals classified according to the continuum of post-acute care on site. Exploratory multivariable analyses revealed independent associations between stroke patient outcomes and (1) staffing ratios for nurses and physicians, (2) the diversity of physician and rehabilitation staff, (3) presence of a simulated home environment, and (4) the total number of care settings on site.

Conclusions. The PAC continuum defines an important hierarchy of stroke rehabilitation services.

Key Words. Rehabilitation, physical therapy, processes, outcomes of care, health care organization, stroke

Individuals with disabilities need access to appropriate rehabilitation services. From 1985 to 1994, rehabilitation grew very rapidly compared to other sectors of the health care industry (Gornick and Hall 1998). Recent years also have seen changes in the sites for provision of rehabilitative care. Particularly prominent within managed care markets has been a decline in occupancy rates and lengths of stays in rehabilitation hospitals; patients in these markets are more likely to be sent to nursing homes for rehabilitation (Retchin, Brown, Yeh, et al. 1997). The changes in location of care for rehabilitation services are probably a response to the pressure to control costs. Costs for stroke rehabilitation are $8,000–12,000 higher per patient in a rehabilitation hospital compared to care in a nursing home (Kramer, Steiner, Schlenker, et al. 1997).

Although the costs may be higher compared to traditional medical care, mortality is lower and functional outcomes are better when disabled patients are cared for in specialized units for post-acute care (PAC) (e.g., geriatric evaluation and management units, stroke units, rehabilitation hospitals) (Kramer, Steiner, Schlenker, et al. 1997; Stroke Unit Trialists' Collaboration 1997; Stuck, Siu, Wieland, et al. 1993). However, we do not know if important differences exist among different types of settings for specialized PAC (e.g.,

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geriatric units versus stroke units), nor do we know what specific characteristics may be responsible for the differences in outcomes with specialized PAC. If we could identify the most critical rehabilitation characteristics, we might be able to deliver optimal rehabilitation in a more cost-effective fashion by eliminating unnecessary services, thus enabling provision of care to a greater proportion of individuals with stroke. We do know that the types of services and the process of care differ across PAC settings. Typically, nursing homes provide fewer rehabilitation treatment sessions and physician visits, and patients are less likely to have a multidisciplinary team providing care compared to the process of care in rehabilitation hospitals (Kramer, Steiner, Schlenker, et al. 1997; Wright et al. 1996). Special units for rehabilitation are more likely to have multidisciplinary teams, specialization of the medical and nursing staff in stroke care, and educational programs related to stroke care, compared to services available on general medical care wards (Stroke Unit Trialists' Collaboration 1997). Thus, differences in structure and process of care may explain the improved outcomes among stroke patients treated in specialized PAC units.

Accurate information about current systems of providing stroke rehabilitation care may help identify optimal resources for PAC and the configuration of those resources. In contrast to the private sector, where data can be limited and difficult to obtain, the Veterans Health Administration (VHA) offers a rich array of computerized and centralized data and an organizational structure that lends itself to obtaining system-wide survey data. The VHA is a national managed health care organization that provides a continuum of acute and post-acute care to eligible veterans. Until recently, resources and organization of care were determined by the individual Veterans Administration Medical Centers (VAMC) in accordance with national VHA policies, thus fostering variation in stroke rehabilitation resources and organization. Examination of these VA-based patterns of care may provide insights into rehabilitation care in the private sector as well. We used VHA data to determine first whether stroke patient outcomes in the VHA were consistent with findings in other health care organizations (i.e., better stroke patient outcomes being associated with specialized PAC). Second, assuming the former was true, we wanted to identify key characteristics that might underlie such differences in outcomes. Specifically, our research questions were:

1. Is there a relationship between the on-site continuum of PAC and stroke patient outcomes, such that stroke patients in the VHA have better outcomes when cared for in hospitals with greater availability of specialized PAC?

2. Do specific rehabilitation resource and organizational factors exist that are independently associated with differences in stroke patient outcomes, after controlling for patient characteristics and other rehabilitation characteristics?

METHODS

DATA SOURCES

Data sources included two mailed surveys of VHA Acute Care and Rehabilitation Medicine Services, supplemented with extant VHA databases. These have been fully described elsewhere (Hoenig, Sloane, Horner, et al. 2000) and are briefly described as follows:

Survey Data

A mailed survey of VA rehabilitation services for stroke (VA Rehabilitation Survey) was the main source of data in this study. All VA facilities listed in the 1996 Directory of VA and Department of Defense Health Care Facilities were surveyed, including all outpatient and support clinics (166 surveys were mailed to facilities comprising 182 geographically distinct sites). Response rate was 100 percent. It was supplemented with results from a 1994 mailed survey of VA resources for acute care (VA Acute Care Survey) sent to 158 acute care facilities in the VA (98 percent response rate).

VA Central Office Data Sources (VACO Data)

1. Summary of Medical Programs FY 96: This VA publication provided facility-specific program data for Fiscal Year 1996.
2. VA Headquarters Offices for Physical Medicine and Rehabilitation Service (PM&RS), Geriatrics and Extended Care, Blind Rehabilitation Service, Spinal Cord Injury and Disorders Strategic Healthcare Group, Employee Education, Academic Affiliations: These offices provided information about resources and organization of their specific programs.

VA Computerized Data Sources

1. VACO Personnel and Accounting Integrated Data database (PAID data): This is the major accounting system for personnel in the VHA. For each individual employee there is information regarding his or

her cost center, job title, salary, and education level. Data were obtained from payroll records for the fiscal quarter ending September 30, 1995. The PAID data include only VA staff personnel; data on contractual personnel were obtained from the VA Rehabilitation Survey.

2. VA Patient Treatment File (PTF data): This computerized database records VA inpatient episodes with accompanying files for (a) the inpatient bed section in which the patient received care, and (b) inpatient procedures the patient received. In two different files, it includes 100 percent of VA hospital discharges, extended care discharges (i.e., discharges from VA and non-VA nursing homes), and non-VA hospital discharges at VA expense.
3. Resource Planning and Management Workload Data (RPM data): This computerized database was used to measure rehabilitation workload for use as a weighting factor for multisite VAs (see below) and as a way to put provider and physical resources in the context of the local demand for those services. This comprehensive rehabilitation workload measure was based on the estimated annual cost of care for patient groups that are typically high users of rehabilitation, prorated for care the patient received in other VA facilities (Department of Veterans Affairs 1994). The rehabilitation workload for a VA facility is the sum of the selected patient groups of the (prorated) patients treated within each of the select patient groups seen in that facility times the estimated annual cost of treating patients within that patient group. Rehabilitation workload data were obtained for the time period October 1, 1994 through September 30, 1995.

STUDY SAMPLE

Hospital Sample

One hundred and sixty-six surveys were sent to VA facilities consisting of 182 geographically distinct sites. Of these sites, 40 were geographically distinct but were administratively linked with one or more other sites; 142 were geographically *and* administratively distinct sites. The 40 geographically distinct but administratively linked sites represented cases where data needed to be consolidated to ensure all data applied to the same unit of analysis ($n = 15$) or for which data were already consolidated ($n = 25$). When data needed to be consolidated, depending on the type of data, we used either an additive approach or a weighted average to derive the data. The weight

for each contributing VA within a multisite VA was based on the relative magnitude of the RPM rehabilitation workload data. This consolidation resulted in data on 19 multisite VAs, which, combined with our geographic site-specific data on 142 VAs, resulted in an initial hospital sample of 161 VAs. Finally, 12 out of these 161 VAs either did not have an acute care setting ($n = 9$) or did not have a stroke patient hospitalized in their acute care setting during the study period ($n = 3$), resulting in a final hospital sample of 149.

Patient Sample

The patient sample included all veterans discharged from VHA medical facilities during the June 1995 through May 1996 period with (1) a primary diagnosis (DXLSF) of acute stroke (ICD-9-CM 430–432, 434, 436); (2) a primary diagnosis of rehabilitation (ICD-9-CM code V57) ***plus*** a secondary stroke-related diagnosis (ICD-9-CM 430–438, 342); or (3) a primary diagnosis related to transient ischemia (ICD-9-CM 433, 435) ***plus*** a secondary stroke-related diagnosis ($n = 11{,}640$). The stroke patient sample was limited to community-dwelling stroke patients admitted (directly or through the emergency room) into an acute bed section (general medicine, neurology, medical ICU) ($n = 6{,}905$). We further limited the study sample to the 6,666 stroke patients who survived at least five days and therefore met VA guidelines for initial evaluation by a rehabilitation practitioner (PM&RS 1995).

OUTCOMES VARIABLES

Outcomes variables examined in this study were (1) the final destination of the patients after completion of their stay in the VA facility to which they were admitted for the acute stroke (discharge to the community versus any other location), and (2) total length of stay in the VA facility (i.e., length of stay from admission to the VA facility with a diagnosis of acute stroke until discharge from that hospital, inclusive of transfers to other wards within the same VA facility). We also explored length of stay in and discharge destination from the bed section or ward to which the patient was initially admitted. We examined this in case differences in total length of stay might be due to differences in acute care rather than post-acute care, and to determine to what extent differences in discharge destination might be related to acute care rather than a function of availability of post-acute care. However, as our main outcome variables we used total length of stay and final discharge destination because our interest was in post-acute rather than acute care. Given the nature of the databases, other outcomes such as functional status were beyond the scope of this study.

PREDICTOR VARIABLES

Predictor variables included patient characteristics (covariates) and rehabilitation characteristics. Patients were described according to demographics (age, sex, race), comorbidity (modified Charlson index classified as 0, 1, 2, 3, or more with exclusion of stroke in the scoring), and stroke severity (Deyo, Cherkin, and Ciol 1992). Stroke severity was measured by two proxies: (1) intubation (any versus none), and (2) transfer from the first acute care setting directly to a PAC setting versus transfer to another acute care setting (e.g., ICU to general medicine, neurology to general medicine). While neither of these are direct measures of stroke severity, Horner and colleagues showed intubation is a reasonable proxy for coma in acute stroke patients (Horner, Sloane, and Kahn 1998), and care in multiple acute care settings represents care either in the ICU or in a neurology ward, and as such would be associated with more medical complications, greater stroke severity, or both.

Rehabilitation variables were identified for the study in conjunction with a panel of expert rehabilitation researchers and clinicians using an a priori model for measuring rehabilitation characteristics (Duncan et al. 1994; Hoenig, Horner, Duncan, et al. 1999; Hoenig, Sloane, Horner, et al. 2000). This approach resulted in a rich data set, for which a number of data reduction strategies were employed. In the case of data available from more than one source, retained variables were chosen based on (1) apparent or known accuracy of the data, (2) proximity of data to the period of time used to identify the patient sample, and (3) the available unit of analysis (this changed from 1995 to 1996 for some data sources but not for others due to VA-wide administrative consolidation). Variables with less than 5 percent variance across VA hospitals were deleted, along with variables likely to be inaccurate based on pilot tests, presence of extreme outliers, or telephone follow-up. Summary variables were derived to describe the VA facility as a whole (e.g., number of different types of physician specialists) and for rehabilitation as a whole (e.g., number of different types of rehabilitation specialists).

We derived two sets of variables to categorize these rehabilitation characteristics: (1) a rehabilitation typology, classifying the VA hospitals according to the continuum of PAC settings in the facility, based on existing data for the merits of differing types of PAC settings (e.g., geriatric evaluation units, stroke rehabilitation units, rehabilitation intensive nursing homes, skilled care facilities); and (2) a rehabilitation taxonomy that used an empirical approach to derive a list of key rehabilitation characteristics.

Rehabilitation Typology

VA facilities were categorized according to the continuum of PAC settings on site. The PAC classification was based on observational studies, randomized controlled trials, and meta analyses indicating better outcomes for disabled patients, older patients, and stroke patients cared for in geriatric evaluation and management units, specialized stroke units, and rehabilitation hospitals compared to care in nursing homes, subacute rehabilitation settings, or traditional medical care (Kramer, Steiner, Schlenker, et al. 1997; Stroke Unit Trialists' Collaboration 1997; Stuck, Siu, Wieland, et al. 1993). Since these studies examined the effects of either geriatric units or stroke rehabilitation units, but not both settings, and since these units may differ in key characteristics, we distinguish among facilities with rehabilitation units versus geriatric units. Within the VHA, the setting most analogous to a rehabilitation hospital is the rehabilitation bed unit (RBU), in that medical directors of RBUs usually have specialty training in rehabilitation and many RBUs have achieved or are pursuing Commission on Accreditation of Rehabilitation Facilities (CARF) accreditation (Lucht 1998). Within the VHA, geriatric evaluation and management units (GEMUs) also offer specialized PAC. GEMUs differ from RBUs in that the medical directors of GEMUs usually have specialty training in geriatrics rather than rehabilitation or stroke per se, and, while a team approach is used in the care of patients, the kinds and amounts of rehabilitation services are not specified and there are no rehabilitation-related accreditation requirements (Wieland, Rubenstein, Hedrick, et al. 1994). Based on these data, the PAC classification was: (1) no post-acute care (No PAC); (2) nursing home, intermediate, or subacute rehabilitation care only (Basic PAC); (3) GEMU on site, alone or in addition to basic post-acute care (+GEM); and (4) RBU on site, alone or in addition to any combination of other post-acute care settings (+RBU).

Rehabilitation Taxonomy

Methods used to develop the taxonomy of rehabilitation characteristics that formed the basis for this study have been described elsewhere (Hoenig, Sloane, Horner, et al. 2000). Variables were retained in the rehabilitation taxonomy if they showed a statistically significant correlation with the PAC typology or if they were endorsed by an expert panel using a modified Delphi process. Detailed definitions for the taxonomy variables can be found in the Appendix and are summarized as follows:

1. Personnel: Personnel data included (a) staffing intensity (number of specific types of rehabilitation providers/total rehabilitation workload), (b) diversity of personnel, (c) use of professional compared to paraprofessional staff, (d) use of new graduates, and (e) amount of continuing education. Personnel measures (e.g., staffing intensity, staff diversity, use of new graduates) included specific types of rehabilitation personnel depending on availability of data for these professionals and likelihood that a substantial proportion of clinicians in that group were involved in stroke care in the VA, based on clinical judgment. The types of professionals included in the differing personnel measures are specified in the Appendix.
2. Physical facilities: Descriptors of physical facilities included presence of an adaptive kitchen, a simulated home environment, or both, use of prefabricated versus individually fitted ankle-foot orthoses, and the variety of equipment available for rehabilitation.
3. Coordination of care: Coordination of care was measured according to (a) number of different staff attending team meetings, (b) how often the therapists at team meetings (rounding therapists) were the same therapists treating the patient (treating therapists) versus someone providing a report from the treating therapist, and (c) use of paid escorts to transport patients to therapy.
4. Hospital-level descriptors: The facility as a whole was described according to (a) teaching affiliation (joint appointment of medical staff, number of rehabilitation training programs), (b) volume of care (number of stroke patients, rehabilitation workload), (c) hospital size (number of hospital beds, number of different settings available for care of stroke patients), (d) availability of therapy on the weekend and in the home, (e) recent organizational change, and (f) distance of the hospital from the patients' home.

ANALYTIC METHODS

Statistical Analysis

Descriptive statistics (means and standard deviations for continuous variables, proportions for categorical variables) were used to portray the types of settings available for acute and post-acute care and to portray patient characteristics across the differing settings in the rehabilitation typology. *P*-values were derived for continuous variables using the Kruskall-Wallis test and for categorical

variables with the Mantel-Haenzel chi-square statistic using modified ridits analysis (Fleiss 1981).

We examined the variation across the hospital types in organization and resources for rehabilitative care of stroke patients by use of an omnibus test to determine whether a significant overall association existed between hospitals classified according to the rehabilitation typology and the distribution of the specific rehabilitation characteristics.

A mixed-model approach was used to determine if the rehabilitation typology or the taxonomy of rehabilitation characteristics, in the presence of important patient-level factors, had statistically meaningful effects on the two patient outcomes, length of stay and discharge destination. We used the mixed-model approach for these analyses because hospitals and patients could be represented as random effects while specific patient- and hospital-level factors of interest were introduced as fixed effects, enabling us to account for the clustering of patients within hospitals. A mixed model assumes that a normally distributed response variable is determined by fixed and random effects (Littell et al. 1996).

Length of stay was transformed by a log function to create a normally distributed variable and analyzed with a mixed-model analysis-of-variance program, SAS PROC MIXED, that adjusted for the effect of the clustering of measurements within hospitals. For the dichotomous outcome, discharge destination (discharge to the community versus any other location), the SAS GLIMMIX macro was used.

To reduce the amount of statistical testing when analyzing the rehabilitation taxonomy, first we examined the relationship of categories of variables (personnel, physical facility, coordination of care, and hospital characteristics) to patient outcomes, adjusting for patient characteristics. For each category, the following procedure was used: the effect of the category was assessed by a chi-square statistic calculated from the difference between the REML 2 log likelihood values for the model without including any other categories of rehabilitation characteristics (but while including all of the patient characteristics) and that of the model with all of the categories included. The number of rehabilitation characteristics (variables) in the category being tested represented the number of degrees of freedom for the goodness of fit test for that category. If the chi-square test indicated a category of rehabilitation characteristics contributed to the patient outcome, that category of variables was further examined using backward selection to identify the specific rehabilitation characteristics that independently contributed to patient outcomes. Finally, only patient characteristics and significant rehabilitation characteristics for a

given category remained in the model. Due to the exploratory nature of this study, we considered a p-value of <.10 to be significant. This procedure was conducted for each of the four categories of rehabilitation characteristics in the rehabilitation taxonomy. The final model included the patient-level characteristics and all of the rehabilitation taxonomy characteristics remaining from the above modeling.

RESULTS

Across the VHA, multiple types and combinations of post-acute settings were reported. Eighty percent of all VA facilities reported having a nursing home, 56 percent had an intermediate care ward, 9 percent had a subacute unit, 50 percent had a geriatric unit (GEM), and 41 percent had a rehabilitation unit (RBU). With regard to acute care facilities, 44 percent of VAs had specialized neurology beds, and presence of specialized neurology beds was associated with an eight-fold greater likelihood ($p < .001$) of having specialized PAC (geriatric or rehabilitation unit) in the same VA facility.

Table 1 shows the distribution of acute stroke patients, and the patients' characteristics, among VA hospitals classified by PAC type. Although a significantly greater ($p < .001$) proportion of stroke patients was admitted to hospitals with rehabilitation units, fully 27 percent of stroke patients cared for in the VA were not in a facility with on-site availability of either a geriatric or rehabilitation unit, and nearly 50 percent were not in a facility with on-site access to a rehabilitation unit. Acute stroke patients in hospitals with No PAC or Basic PAC were more likely to be white ($p < .001$) and less likely to be intubated ($p < .01$) than patients in +GEM or +RBU hospitals. Length of stay varied substantially among the different hospital types, primarily due to differences in PAC—length of stay in the ward to which the patient was initially admitted differed by only two days across the hospital types ($p < .05$); however, total length of stay (i.e., from admission to acute care until discharge from the VA hospital) differed by over ten days across the different types of hospitals, and this difference was highly significant ($p < .001$). There were significant differences across facility types in the likelihood that patients were discharged directly home versus transferred to another ward or facility ($p < .001$) and in the likelihood that patients ultimately returned home ($p < .001$). Patients in hospitals with No PAC were most likely to be directly discharged home from acute care (62.8 percent), but VA hospitals at the highest end of the PAC continuum (+RBU) had the highest overall rate of community discharge

Table 1: Comparison Number of Stroke Admissions, and Stroke Patient Characteristics, Among VA Hospitals Classified by Level of PAC on Site

	No PAC†	*Basic PAC*‡	*+GEM*§	*+RBU*¶	P-*Value**
Stroke patient characteristics	$n = 8$	$n = 49$	$n = 31$	$n = 61$	
Number of stroke admissions (%)	306 (4.4)	1582 (22.9)	1431 (20.7)	3586 (51.9)	.001
Median number of stroke admissions (mean)	40.5 (38.2)	32.0 (32.3)	45 (46.2)	53 (58.8)	
Age—mean (SD)	67.9 (9.9)	68.7 (9.2)	67.5 (9.8)	67.8 (9.8)	.02
White race (%)	75.8	82.9	63.9	63.1	.001
Male (%)	97.4	98.2	98.7	98.4	.35
Charlson score ≤ 3	22.6	25.2	27.4	27.2	.08
Intubated (%)	2.3	2.7	2.7	3.7	.01
Length of stay (acute)—mean (SD)	8.9 (11.1)	9.0 (9.0)	10.9 (12.1)	9.7 (10.7)	.05
Total length of stay	10.9 (12.0)	16.6 (27.3)	19.9 (24.4)	21.5 (25.5)	.001
Discharged home from first bed section (%)	62.8	50.4	42.2	47.7	.001
Discharge home from final bed section (%)	71.6	66.6	71.8	75.0	.001
Transferred to another VA	6.4	7.9	4.0	1.5	.001

*Continuous variables were evaluated with the Kruskall-Wallis test and categorical variables with the Mantel-Haenzel modified ridits chi-square test.

†No PAC settings.

‡Nursing home, intermediate care, or subacute care wards only.

§ Geriatric unit on site, alone or in addition to Basic PAC.

¶Rehabilitation unit on site, alone or in addition to any other combination of PAC.

(75.0 percent). Transfer of stroke patients among VA facilities was rare. No more than 8 percent of patients in any of the facility types were transferred to another VA facility, although the rate of transfer was significantly higher ($p < .001$) for VA hospitals with No PAC or Basic PAC only.

Table 2 shows the distribution of the rehabilitation resources and organizational characteristics across the different types of VA hospitals. Many of these variables differed substantially in availability across the hospital types. With the exception of physical therapists and speech pathologists, all of the personnel variables differed across hospital types, generally showing greater availability moving up the PAC continuum from hospitals with Basic PAC, to those with geriatric units, to those with rehabilitation units. This was most marked for physician availability and for the diversity of rehabilitation providers and physician specialists on staff. Differences across hospital types

Table 2: Comparison of Rehabilitation Variables Across Different Types of VA Hospitals (classified by level of PAC)

Rehabilitation Variable	*Hospital Type (Level of Post-Acute Care) Mean (SD) or Proportion*†				P-*Value from Omnibus Test*‡
	No PAC (n = 8)	*Basic PAC (n = 49)*	*GEM+ (n = 31)*	*RBU+ (n = 61)*	
Personnel					
Number of PTs/rehabilitation workload	3.53 (2.3)	2.15 (1.6)	2.44 (2.0)	2.61 (1.6)	.24
Number of OTs/rehabilitation workload	2.38 (2.8)	2.16 (2.7)	2.22 (1.9)	2.61 (1.4)	.05
Number of SLPs/rehabilitation workload	1.07 (0.9)	0.78 (0.6)	0.99 (0.8)	0.92 (0.7)	.56
Number of RNs/rehabilitation workload	177 (39)	149 (128)	158 (71)	141 (62)	.07
Number of PMRS MDs/rehabilitation workload	0.47 (0.6)	0.63 (1.0)	0.86 (0.6)	1.27 (0.7)	.0001
Diversity of allied health professions (number of different types)	3.50 (1.2)	3.9 (1.0)	4.42 (0.8)	4.69 (0.6)	.0001
Number of new graduates on rehabilitation staff	0.87 (0.8)	0.74 (1.0)	1.13 (1.1)	1.86 (1.8)	.002
Proportion of clinical staff that are paraprofessionals	0.76 (0.1)	0.74 (0.1)	0.77 (0.1)	0.82 (0.1)	.0005
Tuition support ($/clinician)	460 (604)	347 (286)	421 (288)	522 (559)	.09
PT specialist in stroke (%)	25.0	52.2	51.6	50.0	.61
Nurse specialist in stroke (%)	0	14.3	12.0	39.0	.001
Number of different physician specialists	5.50 (1.4)	4.23 (1.8)	5.16 (1.6)	5.98 (1.4)	.0001
Physical facilities					
Diversity of rehabilitation equipment (number of different types)	6.37 (1.8)	7.10 (1.9)	7.93 (1.6)	8.46 (1.6)	.0004
Ankle-foot orthosis (%)	75.0	25.0	45.1	50.0	.19
Simulated home environment (%)	12.5	16.3	9.7	29.5	.07
Adaptive kitchen (%)	50.0	51.0	83.8	82.0	.001
Adaptive bathroom (% of settings)	25.0 (46)	47.8 (37)	41.7 (43)	44.2 (39)	.21
Coordination of care					
Number of different professions at team meeting	4.75 (2.0)	6.19 (2.1)	6.25 (2.3)	8.40 (2.1)	.0001

Continued

Table 2: *Continued*

Rehabilitation Variable	*Hospital Type (Level of Post-Acute Care) Mean (SD) or Proportion*†				*P-Value from Omnibus Test*‡
	No PAC (n = 8)	*Basic PAC (n = 49)*	*GEM+ (n = 31)*	*RBU+ (n = 61)*	
Uses guidelines (%)	0	14.3	19.4	23.3	.09
Escort service (%)	37.5	29.2	46.7	57.6	.005
Rounding therapist is also the treating therapist (%)	28.6	30.4	30.0	49.2	.04
Hospital characteristics					
Number of rehabilitation training programs	1.75 (1.2)	1.49 (1.5)	1.93 (1.4)	2.84 (1.5)	.0001
Joint affiliation (%)	50.0	47.9	73.3	81.4	.001
Number of CVA patients (mean)	38.2 (27.2)	32.3 (18.7)	49.3 (36.7)	58.8 (43.0)	.002
Rehabilitation workload	915 (394)	1225 (656)	1689 (990)	2774 (1555)	.0001
Total number of beds in hospital	152 (85)	315 (196)	456 (246)	634 (334)	.0001
Total number of post-acute settings	2.37 (0.8)	3.73 (1.1)	5.06 (1.3)	6.44 (1.3)	.0001
Total number of settings for stroke care	0 (0)	1.41 (0.5)	2.51 (0.9)	3.33 (0.9)	.0001
Availability of home health services	37.5	32.7	41.9	65.6	.001
Therapy on weekends	12.5	26.5	29.0	28.3	.52
Organizational change	0	44.9	32.3	34.4	.94
Outpatient travel > 1 hour	50.0	22.5	25.8	31.2	.83

†For continuous variables: means and standard deviations are shown. For dichotomous variables: (designated with a "%" after variable name), the proportion of VAs with a positive response are shown.

‡*P*-value for omnibus test obtained from Kruskal-Wallis or Mantel-Haenzel chi-square.

in physical facilities were most notable for the diversity of rehabilitation equipment and availability of an adaptive kitchen. While all of our measures of coordination of care differed across the hospital types, differences were greatest for the number of different professionals attending team meetings and use of a paid escort service for patient transport. Hospital characteristics also differed substantially among the hospitals. Educational affiliations and measures of hospital size generally increased, moving up the PAC continuum.

Table 3: Multivariable Regression Examining Patient Outcomes in VA Hospitals Classified According to Availability of PAC Services (Rehabilitation Typology), Controlling for Patient Characteristics

	Log Length of Stay		*Discharge to Home*[1]		*Discharge to Home*[2]	
Predictor	*Beta*	P-*Value*	*Beta*	P-*Value*	*OR*	*95% C.I.*
Age > 70	.18	.0002	.55	.41–.73	.62	.55–.70
White race	–.09	.003	.01	.78–1.07	.92	.79–1.06
Charlson comorbidity*						
Charlson = 1	.13	.002	1.05	.86–1.29	1.20	1.00–1.45
Charlson = 2	.54	.001	.75	.62	.90	.70–.99
Charlson = 3+	.68	.0001	.62	.52–.75	.70	.59–.82
Intubated	.27	.001	.13	.09–.19	.10	.06–.15
Length of stay	N/A	N/A	.98	.98–.98	.98	.98–.99
Second bed section an acute bedsection	.36	.0001	.65	.56–.76	.56	.48–.64
PAC services†						
No PAC	–.13	.267	1.04	.58–1.87	1.10	.65–1.86
+GEM	.24	.001	1.07	.76–1.51	1.43	1.03–1.97
+RBU	.30	.0001	1.32	.99–1.76	1.91	1.47–2.50

*Reference = Charlson 0.

†Reference = Basic PAC.

[1]Transfers = community discharge.

[2]Transfers = institutional discharge.

Table 3 shows the relationship of the PAC continuum to outcomes after controlling for patient characteristics. Since 3.6 percent of the study population transferred to another VAMC as their final discharge destination from the index admission, and the ultimate fate of those patients was unknown (e.g., discharge to the community, death, etc.), we examined the discharge outcomes for stroke patients under two different assumptions. The first case assumes that transfer of a patient to another VA was equivalent to discharge to an institutional setting; the second assumes that all inter-VA transfers were for additional rehabilitation and, furthermore, that the rehabilitation resulted in discharge to the community. In other words, these assumptions present a best-case and a worst-case scenario for the transferred patient. Table 3 shows results for discharge destination both for the best- and worst-case scenarios. In the worst-case scenario, we found that after adjusting for patient covariates, patients in hospitals with rehabilitation units stayed in the hospital five days longer on average than patients in hospitals with Basic PAC, but they were approximately 90 percent (OR 1.91, 95 percent CI 1.47–2.50) more likely

to be discharged to the community. Patients in hospitals with geriatric units but without rehabilitation units had outcomes intermediate to Basic PAC- and +RBU-type hospitals, averaging three days longer in the hospital and having a 40 percent (OR 1.43, 95 percent CI 1.03–1.97) greater likelihood of discharge to the community compared to patients in Basic PAC hospitals. VA hospitals with No PAC did not differ significantly from those cared for in VA hospitals with Basic PAC either in the likelihood their patients were discharged to the community or in length of stay. Under the assumption that all transferred patients were transferred for additional rehabilitation *and* ultimately returned to the community, the odds ratio for discharge to the community, adjusting for patient covariates, was 1.32 (0.99–1.76) for hospitals with rehabilitation units and 1.07 (0.76–1.51) for hospitals with geriatric units compared to Basic PAC hospitals. Under either assumption, differences in discharge destination among hospital types appear to become more marked after adjusting for patient characteristics (i.e., the patient profile in the Basic PAC hospitals is one that is likely to be associated with more favorable outcomes) (data not shown).

Table 4 shows the relationship of conceptually distinct categories of rehabilitation characteristics, and variables within those categories, to patient outcomes, controlling for patient characteristics. At this level of analysis, we did not control for all the other categories of rehabilitation characteristic simultaneously, but rather examined each category individually, adjusting for patient characteristics. All four conceptually distinct categories of rehabilitation characteristics had statistically significant associations with length of stay, and three out of the four categories of variables were associated with statistically significant differences in discharge destination. Table 4 also shows statistically significant beta coefficients for individual variables within each conceptually distinct category of rehabilitation variables.

Table 5 shows a multivariable regression for which stepwise backwards selection was used to determine which individual rehabilitation taxonomy variables, from the four conceptually distinct categories of rehabilitation variables, were independent predictors of outcomes, after accounting for each other and for patient characteristics. Longer length of stay was associated with lower rehabilitation workload per rehabilitation physician ($p < .001$), greater diversity of rehabilitation staff ($p < .003$), and presence of a simulated home environment ($p < .03$). Greater availability of nursing personnel was associated with a slightly shorter length of stay ($p < .01$). Discharge home was associated with greater diversity of acute care physicians and a greater number of different on-site settings for stroke care.

Table 4: Comparison of Categories of Rehabilitation Characteristics and Individual Rehabilitation Characteristics to Patient Outcomes, Controlling for Patient Characteristics

	Log Length of Stay		*Discharge Destination*	
Rehabilitation Characteristic	*Overall P-Value for Category*	*Beta Coefficient for Individual Variable*[*]	*Overall P-Value for Category*	*Beta Coefficient for Individual Variable*[*]
Personnel	.0001		.0001	
No. OT/wkld[a,b]				
No. PT/wkld[a]				
No. RN/wkld[a]		−.0022		
No. rehab MD/wkld[a,b]		.187		
No. SLP/wkld[a]				
No. different allied health professions[b]		.092		
No. different MD specialist types[a,b]				1.13
Therapists/therapists + aids[b]				
No. new graduate therapists[a,b]				
Nurse specialist in stroke[b]				
Tuition support ($/clinician)[b]				
Coordination of care	.0001		.01	
No. professions on rounds[b]		.05		
Rounding therapist = treating therapist[a,b]				
Use stroke guidelines[a]				
Escort service[b]				
Physical facilities	.0001		.59	
No. different types equipment[b]				
Use prefabricated AFO[b]				
Simulated home environment[a]		.153		
Adaptive kitchen[a,b]		.138		
Patient room has adaptive toilet[a]				
Hospital characteristics	.0001		.0001	
No. rehab training programs[b]				
Joint academic appointments[b]				1.01
No. stroke patients[a,b]				
Rehabilitation workload[a,b]				
No. hospital beds[b]		.076		1.10
No. settings for stroke care[b]		.106		
Recent organizational change[a]				
Home health available[a,b]				
Weekend therapy available[a]				
Outpatient travel 1 hour[a]				

[*] $p < .1$.

[a]Expert panel endorsement.

[b]Statistically significant correlation with PAC continuum.

Table 5: Multivariable Hierarchical Linear Regression, Using Backward Selection, to Identify Rehabilitation Characteristics Independently Associated with Patient Outcomes After Controlling for Stroke Patient Characteristics

Patient or Rehabilitation Characteristic	*Log Length of Stay*		*Discharge to Community*	
	Beta	P-*Value*	*Odds Ratio*	P-*Value*
Patient characteristic				
Age > 70	.176	.001	.60	.001
White race	−.08	.0065	.92	.31
Charlson = 1*	.13	.0001	1.13	.18
Charlson = 2*	.55	.0001	.73	.0003
Charlson ≥ 3*	.71	.0001	.54	.0001
Intubated	.41	.0001	.07	.0001
Died in hospital	.16	.0015		NA
Personnel				
RNs/workload	−.001	.01		NA
Rehabilitation MDs/workload	.175	.0001		NA
No. different allied health professions	.09	.005		NA
No. different MD specialist types	NA	NA	1.09	.02
Physical facilities				
Simulated home environment	.13	.03	NA	NA
Hospital characteristics				
No. settings for stroke care			1.08	.02

*Reference Charlson = 0.

DISCUSSION

This study shows substantial variation across the VHA in organization and resources for rehabilitative care of stroke patients. These differences in structural organization of care were associated with important differences in patterns of care and stroke patient outcomes. Presence of a rehabilitation unit appeared to be a marker for a constellation of PAC resources associated with better outcomes. VA facilities with a geriatric unit but without a rehabilitation unit had intermediate outcomes. This is the first study we know of to show a hierarchical relationship between availability of different types of specialized PAC (specialized for rehabilitation versus specialized for the geriatric population versus no specialization) and stroke patient outcomes. Using a systematic approach, we also were able to identify several salient characteristics that may underlie some of the differences in outcomes seen with specialized PAC care for stroke patients. While previous studies indicated that dedicated

rehabilitation units have better stroke patient outcomes, the reasons for the improved outcomes were not fully identified.

Few researchers have attempted to identify the key attributes producing the more optimal outcomes from specialized stroke care, and none have taken a comprehensive approach, using an a priori approach to identify variables of interest and comparing them to patient outcomes. The Stroke Unit Trialists' Collaboration recently used meta analysis of existing stroke trials to show that the more successful stroke units were characterized by coordinated multidisciplinary rehabilitation, use of education and training programs in stroke, and specialization of medical and surgical staff (Stroke Unit Trialists' Collaboration 1997). Wieland and colleagues examined geriatric units within the VA and found them to be a fairly diverse group, falling into two main categories: standard (56 percent of geriatric units) and nonstandard (44 percent of geriatric units) (Wieland, Rubenstein, Hedrick, et al. 1994). Standard units had better outcomes and were characterized by use of comprehensive patient assessment; specifically assigned physicians, nurses, and social workers; use of targeting criteria for patient admission; location in acute or intermediate care wards; and active management of rehabilitation and outpatient follow-up. Our data corroborate some of these findings (e.g., availability of a diversity of rehabilitation and physician specialists distinguished among facilities and predicted differences in patient outcomes), and they provide some new insights. Our finding that hospital lengths of stay for stroke patients are shorter when rehabilitation physicians care for more patients is the first we know of showing that physician volume of care may affect outcomes for stroke patients, as are our findings that presence of a simulated home environment and availability of a broad continuum of care are associated with differences in stroke patient outcomes.

This study has several important limitations that should be considered in the interpretation of our results. The cross-sectional, observational study design gives a broad overview of variations in organizational resources for stroke care, but it also means that the relationships seen in the study cannot be assumed to be causal. Our data were obtained from multiple data sources over a two- to three-year period of time, and some data are at the patient level while most of the data are at the institutional level. Use of multiple data sources may contribute additional sources of variance in the data, with the result that some relationships that are clinically important at the patient or facility level may not be apparent in our analyses. However, this approach has the advantage of allowing us to consider a wider variety of rehabilitation characteristics than realistically can be obtained through prospective, patient-level data

collection, while use of a mixed model allows us to adjust for the effect of nesting of patients within facilities better than previously possible. We do not specifically examine the rural versus urban nature of the hospitals. However, the mixed-model approach used in our analyses does control for site effects, and we examine a number of variables associated with urban versus rural hospital settings, including hospital size and being a teaching hospital. Our data set did not allow us to track the outcomes of patients transferred to other VA hospitals. Instead, we examined a best-case and a worst-case scenario. The truth probably lies somewhere in between because it is unlikely that the patients transferred from a VA with a rehabilitation unit to another VA were transferred for additional rehabilitation. We conducted extensive statistical testing with the rehabilitation taxonomy variables in an effort to understand which specific variables in the rehabilitation taxonomy were associated with better patient outcomes. This increases the risk that some statistically significant associations are present due to chance alone (Type 1 error). The available data sources did not allow us to control for pre-stroke functional status, nor were we able to control for the role that social support may play in discharge decisions. For these reasons, our results do not provide a comprehensive model for determining which stroke patients are likely to return to the community. Rather, this study allows us to examine the role PAC resources play on stroke outcomes while controlling for some, but not all, of the other factors affecting stroke outcomes. Thus, the analyses of variables in the rehabilitation taxonomy should be viewed as exploratory and requiring confirmation in future studies. While the exploratory nature of our findings is an important limitation that must be acknowledged, these findings also provide important guidance to rehabilitation researchers about aspects of rehabilitation needing more in-depth study.

We identify several potentially fruitful avenues for rehabilitation health services research. For example, several rehabilitation characteristics were associated with longer length of stay but were not independent predictors of discharge destination. These rehabilitation characteristics should be examined to determine if longer length of stay confers significant benefits for the patient not measured by this study (e.g., independence in self-care, ability to walk, better quality of life, lower caregiver burden, etc.) If not, potentially large cost savings could be gained by increasing the efficiency of care. One implication of our study is that attempting to alter the process of care without providing key resources may be ineffective. Our data indicate that key resources, both in the internal staff and in the broader hospital milieu, were associated with important differences in patient outcomes. Ideally this

should be confirmed through interventional trials where such resources are provided to some facilities and not to others in order to determine the relative costs and benefits and the effect of these resources on process of care. Further work along these lines may enable us to confirm the key structural variables facilitating the more successful outcomes seen with specialized PAC and thereby enable provision of the beneficial outcomes from specialized PAC with greater efficiency and lower costs, and thus potentially offer these services at more hospitals. Another important avenue of research is to examine the trade-off of enhancing the rehabilitation resources at all hospitals versus enhancing transfer of patients in need of rehabilitation to hospitals with greater rehabilitation resources. Because even under the best-case assumption (all transferred patients ultimately were discharged to the community), patients in hospitals with rehabilitation units still tended to be more likely to be discharged to the community, either not enough of the right patients are being transferred or rehabilitation at a distant site is not optimally effective at achieving community discharge. This is a key issue for further research. Although on average the veteran stroke population may be older and more impoverished than private sector stroke patients, the private sector deals with this same issue when considering whether to send a stroke patient to a local nursing home for subacute rehabilitation versus sending the patient to a rehabilitation hospital, potentially at some distance from the patient's home.

Despite its limitations, this article sheds some light on specific hospital-level rehabilitation attributes associated with important differences in patient outcomes. Moreover, the PAC continuum identified in this study defines an important hierarchy of stroke rehabilitation services.

APPENDIX

Table A1: List of Rehabilitation Variables Considered for Inclusion in the Rehabilitation Taxonomy, Including Definitions of the Variables and Their Data Sources

Variable	*Definition*	*Source Database*
Facility categorization (typology)		
PAC typology	No PAC versus Basic PAC (nursing home, intermediate care ward, or subacute care unit) versus geriatric evaluation and management unit (GEMU) alone or in combination with Basic PAC versus RBU alone or in combination with any other PAC	VA Central Office Data VA Rehabilitation Survey VA Acute Care Survey
Rehabilitation taxonomy		
Personnel		
No. PT/wkld	Total physical therapists per 1000 units rehabilitation workload	PAID Computerized Database and VA Rehabilitation Survey Workload: RPM
No. OT/wkld	Total occupational therapists per 1000 units rehabilitation workload	PAID Computerized Database and VA Rehabilitation Survey Workload: RPM
No. SLP/wkld	Total speech and language pathologists per 1000 units rehabilitation workload	PAID Computerized Database and VA Rehabilitation Survey Workload: RPM
No. RN/wkld	Total registered nurses per 1000 units rehabilitation workload	PAID Computerized Database and VA Rehabilitation Survey Workload: RPM
No. rehab MD/wkld	Total physicians assigned to Physical Medicine and Rehabilitation Service per 1000 units rehabilitation workload	PAID Computerized Database and VA Rehabilitation Survey RPM Computerized Database
No. different allied health professions	Total number of different types of allied health providers on staff (PT + OT + KT + SLP + RT)	VA Rehabilitation Survey
No. therapist new graduates	Number of therapists on staff who graduated in the last year (PT, OT, KT, SLP)	VA Rehabilitation Survey

Continued

Table A1: *Continued*

Variable	*Definition*	*Source Database*
Therapist/ therapist + aids	Ratio of total allied health professionals to total allied health clinicians (PT + OT + KT + SLP + RT)/ (PT + OT + PTA + OTA + KT + RT + KTA + SLP + therapy aids + therapy assistants)	VA Rehabilitation Survey
Tuition support ($/clinician)	Total tuition support in dollars for PT, PTA, OT, OTA/sum of {PT, PTA, OT, OTA}	Tuition support: Office of Employee Education FY95
Nurse specialist in stroke	Presence of formally or informally designated nurse specialist in rehabilitation	VA Rehabilitation Survey
No. different MD specialist types	Total number of different acute care physician specialists for stroke (neurologist, neurosurgeon, vascular surgeon, neuroradiologist, internist, other internal medicine subspecialties)	VA Acute Care Survey
Physical facilities		
No. different rehabilitation equipment types	Total number of different types of rehabilitation equipment present (parallel bars, mat tables, EMG biofeedback, FES, exercise units, isokinetic, adaptive kitchen, adaptive toilet in clinic, adaptive bath in clinic, simulated home environment, swimming pool)	VA Rehabilitation Survey
Use prefab ankle-foot orthoses (AFO) (%)	In past 12 months, prefabricated AFO used (0 = sometimes, almost never; 1 = often, almost always)	VA Rehabilitation Survey
Simulated home environment (%)	Simulated home environment present (0 = no; 1 = yes)	VA Rehabilitation Survey
Adaptive kitchen (%)	Adaptive kitchen present (0 = no; 1 = yes)	VA Rehabilitation Survey
Adaptive bathroom in patient room (% settings 0/1)	Percentage of hospital settings providing care for stroke patients that have adaptive bathroom in the patient's room	VA Rehabilitation Survey

Continued

Table A1: *Continued*

Variable	*Definition*	*Source Database*
Coordination of care		
No. different professions at team meeting	Total number of disciplines routinely present on interdisciplinary rounds (PT, OT, KT, SLP, PA/NP, SW, rehabilitation nurse, vocational counselor, psychologist, physician rehab, dietician, RT, other)	VA Rehabilitation Survey
Use stroke guidelines (%)	Formal, standard protocol used in the care of stroke patients (0 = no; 1 = yes)	VA Rehabilitation Survey
Escort service (%)	Any use of paid escorts to transport stroke patients to rehabilitation (0 = never use; 1 = any use)	VA Rehabilitation Survey
Rounding therapist = treating therapist	Frequency the treating therapist is also the therapist present at interdisciplinary rounds (0 = sometimes, almost never; 1 = almost always, usually)	VA Rehabilitation Survey
Hospital characteristics		
No. rehabilitation training programs	Number of educational training programs (PT, OT, PTA, OTA, KT, SLP)	
Joint academic appointment for medical staff (%)	Joint appointments of staff at academic medical center	VA Acute Care Survey
No. CVA patients	Total number of community dwelling, acute stroke patients hospitalized at VA facility 6/1/95–5/31/96	
Rehab workload	Adjusted inpatient rehabilitation workload	RPM Computerized Database
No. hospital beds	Total number of hospital beds	FY 95 Summary of Medical Programs
No. settings for stroke care	Total number of acute plus post-acute inpatient settings caring for stroke patient during study period	VA Rehabilitation Survey

Continued

Table A1: *Continued*

Variable	*Definition*	*Source Database*
Availability of home health services	VA facility directly provides home health care service to stroke patients (0 = no; 1 = yes)	VA Rehabilitation Survey
Therapy on weekends	Frequency that a rehabilitation consultation, evaluation, or treatment was provided on a weekend within last 12 months (0 = never; 1 = emergency, occasionally, or routinely)	VA Rehabilitation Survey
Organizational change	Major changes in the organization of rehabilitation services at the VA facility during the last 12 months that could affect stroke rehabilitation outcomes (0 = no; 1 = yes)	VA Rehabilitation Survey
Outpatient travel ≥ 1 hour	Outpatient travel time ≥ 1 hour (0 = almost never/sometimes; 1 = often/frequently)	VA Rehabilitation Survey

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